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PRESSING DOWN THE ROOTS WHICH HAVE BEEN LOOSENED IN HARVESTING.

A WATERCRESS PLANTATION.

WATERCRESS CULTURE IN FRANCE.—[SEE PAGE 377.]

THE VARIOUS TYPES OF GAS LAMP.

THEIR COMPARATIVE PRACTICAL EFFICIENCY.

BY R. C. WARE.

ALTHOUGH there have been numerous and exhaustive researches regarding the practical efficiency of the electric lamps in common use, there has not to the author's knowledge been similar work to determine the actual rating of the different types of gas lamps, and of the same lamp with different glassware. That is, distribution curves have been worked out, and tables have been compiled for showing the comparative consumption and maximum candle-power per cubic foot per hour, or mean spherical candle-power per cubic foot per hour, etc.; but regarding the practical application of the lamps, there are few data.

The author has, accordingly, worked out some rough calculations along this line which may be of interest. He wishes here to express a very high appreciation of the valuable paper contributed at the Philadelphia Convention of the Illuminating Engineering Society by Messrs. Cravath and Lansingh on "The Measurement of Illumination by the Flux-of-Light Method." This method will be found very useful for the rapid determination of the number of lamps required for a given area and specified density of illumination.

It should be explained that the results described below are at best very rough, and, since they were reached purely by calculation and not by actual test, there is likely to be some variation from conditions obtained in actual practice.

There has been chosen for the problem a rectangular room 50 × 30 feet and 12 feet high. The area is sufficiently large to allow the lamps to be so placed, if desired, that where reflectors are used the main flux of light shall be directed entirely at the floor and shall not reach the walls. The plane of illumination is three feet above the floor, and the average illumination to be secured is 3 foot-candles for the whole area. This intensity is pretty generally agreed upon as being a mean which suits most ordinary purposes. It is the usual upper limit for churches, auditoriums, general merchandise stores, etc., and it is the usual lower limit for bookkeeping, desk work and drafting purposes. There is, therefore, an area of 1,500 square feet requiring a supply of 3 lumens per square foot, or 4,500 lumens in all—one lumen being the amount of light required to give an intensity of one foot-candle over a surface of one square foot.

Applying the flux-of-light method, described by Messrs. Cravath and Lansingh, to determine the number of effective lumens given off by the various burners under consideration, the results shown in the accompanying table are obtained. The effective angle of illumination for general lighting purposes has been taken as 60 degrees above the vertical. At the usual height of a chandelier of about 7 feet above the floor, or 4 feet above the plane of illumination, light given off at this angle will strike the plane at a distance of about 7 feet. This angle is possibly somewhat low for the consideration of light sources of high candle-power, but for the consideration of the lower-powered lamps, the light given off above 60 degrees would not play a very large part in the direct illumination. It should be noted, however, that in the case of a large room it is not safe to disregard entirely the direct light given off above this angle, because the total amount of such light coming from many lamps at a distance adds materially to the illumination at any given spot. However, for the more common problem, of a room of only moderate proportions, the angle stated is probably sufficiently correct.

It should be further noted that in all unshaded lamps, except the inverted mantle burner, the maximum intensity of light is given off at about the horizontal. Where the walls of a room are dark, so that reflection from them is missing, it is, of course, desirable to utilize the horizontal rays to as great an extent as may be possible.

In the table there are given two cases. One shows the number of lamps required for the chosen room, where both the ceiling and the walls are dark so that only the direct illumination is utilized. This condition with absolutely no reflection is, of course, almost purely theoretical, and is seldom met in actual practice. Under the second case are shown the number of lamps, etc., required for the same illumination in a room with light ceiling and walls.

As regards the various lamps studied, the open flame burner gives an illumination singularly uniform in every direction, the only point where the intensity falls off materially being in the zone of 5 or 10 degrees directly under the burner. In all other directions the light given off is almost uniform. The adoption of this burner for the dark room in Case 1 would insure a moderately even illumination, provided outlets were arranged in sufficient number, preferably not more than 5 lamps to a fixture. It will be seen that the cost of installation will be high in this case, and the operating cost very high, 69 burners being required.

The bare mantle has a well-defined shadow beneath it, and is objectionable on this account, but is more particularly objectionable by reason of its great brilliancy, and should, of course, never be employed unshaded. Unfortunately, the use of crude unshaded installations on every street is only too common. The number of burners in the chosen problem is only about one-half the number of open flame burners required, this somewhat unfavorable showing being due to the small proportion of light given off below 60 degrees.

An installation of mantle burners equipped with a proper globe requires 33 lamps, the total light given off below 60 degrees being somewhat more than that given by the bare mantle, while the distribution is better, there being no dense shadow beneath the lamp.

ROOM—50 x 30 ft., 12 ft. high; 1500 sq. ft. PLANE OF ILLUMINATION—3 ft. above floor.
INTENSITY—3 ft.-candles. EFFECTIVE ANGLE—60 degrees.

Type of burner	Effective light below 60° in lumens	Light above 60° in lumens	Mean spherical cp.	Cons. cu. ft. per hour	Case 1—Dark room: No. of lamps	Total cu. ft. per hour	Total effective lumens per cu.ft. per hr.	Cu. ft. per hour per ft.-candle per sq. ft.	Case 2—Light room: No. of lamps	Total cu. ft. per hour	Total effective lumens per cu.ft. per hr.	Cu ft per hour per ft.-candle per sq. ft.
Open Burner	65	186	90	5.0	69	345	13.0	0.0767	40	200	22.2	0.0444
Upright Lamp												
Bare mantle	119	672	63	3.7	38	140	32.2	0.0311	16	59	77.5	0.0131
Globe	137	430	45	5.0	33	165	27.4	0.0367	18	90	49.0	0.0200
Opal dome & Bobesche	212	283	39.4	3.6	21	76	58.9	0.0169	16	57	78.6	0.0127
Fluted flat reflector	183	528	56	3.7	25	92	49.5	0.0204	14	52	85.1	0.0116
Inverted Lamp												
Bare lamp	272	507	62	3.22	17	55	84.5	0.0122	11	35	123.9	0.0078
Ground glass	226	420	51.5	3.0	20	60	75.3	0.0133	13	39	110.3	0.0087
Prismatic dist.	446	200	51.5	3.22	10	32	138.5	0.0071	9	29	154.0	0.0064
Clusters												
4 burner upright	1090	1910	239	19.	4	76	57	0.0169	3	57	82.5	0.0127
3 burner inverted	890	1838	217	11.	5	55	81	0.0122	3.3	36	123.0	0.0080

It is interesting to note that the total absorption by this form of shade is about 47 per cent for equal gas consumption. In spite, however, of the loss in efficiency, a burner equipped with this shade is in general far preferable to the open mantle burner, owing to the great decrease in the intrinsic brilliancy of the lamp.

The prismatic shade for the upright mantle burner gives much the same distribution and candle-power below the horizontal as the above mentioned globe, but the absorption is considerably less. Moreover, the shade is more artistic and is for that reason preferable. For general illuminating work, this is probably the most satisfactory of the upright mantle globes and is worthy of more extended adoption.

The next lamp listed is the upright mantle, equipped with an opal dome and bobesche. This lamp gives a powerful light throughout an angle of about 30 degrees from the vertical, and even if hung high is sure to give a spotty illumination. It has been included in the list, however, as it is a very common type and is still widely used for general illumination where some other form of shade might better be employed. For general purposes the distribution would be aided by the omission of the bobesche. Unfortunately, however, the author has been unable to secure curves showing the distribution without the bobesche. Twenty-one lamps with this equipment will be needed to give the total of 4,500 lumens required, but to secure an illumination reasonably even, more lamps would be necessary. It is noteworthy that the absorption of light by this equipment amounts to about 35 per cent.

The last lamp of the upright mantle pattern to be considered is that equipped with the common flat, fluted, opal glass reflector. This equipment gives a fairly good distribution, the chief objection being that the mantle is left exposed to view. The number of lamps of this pattern required to secure fairly even illumination is twenty-five.

It is unfortunate that no effective study of prismatic glassware has been made with a view to providing prismatic reflectors of the pagoda or inverted-bowl type similar, in general, to the bowl reflectors for electric lamps. A reflector of this type could be made to give a very satisfactory distribution curve for the upright mantle burner at very much greater efficiency than is done by any of the reflectors for this type of burner now in use. Inasmuch as the upright will for many years have a very distinct field, it would seem that some investigations might profitably be made along this line by the manufacturers.

Turning to the inverted gas burner which during the past year has been proved thoroughly reliable and efficient, it is found that only 17 of the unshaded lamps are required to give the 4,500 lumens specified. It should be noted here, however, that the inverted lamp should, in general, be hung somewhat higher than has been the custom with the ordinary burners previously in use. The height of about 8 feet will give very satisfactory and uniform results.

The bare mantle, however, even if hung high, is open to the objection common to all incandescent lamps, that the high intrinsic brilliancy is distinctly uncomfortable, although, owing to the larger surface involved, this objection is not so strong as in the case of the electric incandescent lamp.

The inverted gas burner equipped with ground glass globe shows an absorption of about 17 per cent. The distribution is not quite so good as in the case of the bare lamp, there being a small zone of high candle-power at the nadir. Twenty of the lamps would be required, and although the illumination produced would be somewhat more spotty than in the case of the bare mantle, the general effect in the room would be preferable, owing to the diffusion of light at the lamp.

Beyond any question, however, the most satisfactory lamp of those in the table is the inverted mantle equipped with prismatic distributing reflector. The amount of absorption here is about the same as that of the ground glass globe. The distribution, however, is vastly superior and only 10 lamps are required for producing the specified 4,500 lumens. It would, however, be inadvisable to hang these lamps at the usual height of 7 feet, better results being obtained at the height of about 8.5 feet.

The figures referred to thus far were calculated for a room with dark walls and ceiling. Such conditions are, however, extremely rare and account should be taken of the reflection from ceiling and walls. If the amount of light given off above the chosen angle of 60 degrees were the same in all cases, the figures already given would be sufficient to indicate the relative value of the lamps; inasmuch, however, as the light actually given off above 60 degrees varies greatly, as is shown in the table, the second case where light walls and ceiling are specified must be considered.

Messrs. Lansingh and Rolph presented a paper at the convention of the Illuminating Engineering Soci-

* A paper read before the New England Section of the Illuminating Engineering Society. Rearranged for the Transactions and here republished therefrom.

ety in October, showing the increase in horizontal illumination due to light ceiling, light walls, light floor, and to the interaction of these different surfaces with one another. The results were noteworthy. The effective angle in this case was about 50 degrees and an analysis of the light given off above this angle shows that the lumens reflected were between 40 and 50 per cent of the total amount thrown against the walls and ceiling. Their paper, however, was based on purely laboratory conditions.

It may safely be assumed that in ordinary practice the reflection would not be so high as this. The reflection of an ordinary foolscap paper is 70 per cent, of chrome yellow paper about 62 per cent. In ordinary conditions one would probably get a figure lower than this, the ordinary light buff walls and finish and the tinted ceilings which are commonly met with probably giving a diffuse reflection of less than 60 per cent. This figure, of course, would apply for the first direct reflection which would account for only a portion of the total light under consideration. The rest would have to be two, three, four, and more times reflected before it reached the plane of illumination, losing each time in amount. There would also be a loss in reflective efficiency due to the presence of goods, show cases, doors and windows, hangings, pictures, etc., which would vary very greatly with the different cases.

Assuming, therefore, 25 per cent as a basis—probably high for the rough calculations in view—it is found that by adding 25 per cent of the lumens given off above 60 degrees to the effective lumens below 60 degrees, the number of lamps required for the specified illumination of 3 foot-candle on the plane is reduced in the case of the open flame burner from 69 to 40; in the case of the bare mantle from 38 to 16. In this case most of the light is given off above 60 degrees. In the case of the globe where there is less proportional light given off above 60 degrees, the number is reduced from 33 to 18. The same holds true in the case of the fluted opal reflector where most of the light is given off below the horizontal. Here the reduction is from 25 to 14. With the opal dome and bobesche, the number is reduced from 21 to 16. It should be stated here that with this equipment, the lamps should be hung high, as owing to the very powerful light immediately below the lamp the distribution is greatly improved by the added height.

The figures bring out another important consideration, namely, that with light walls and ceiling, a lamp may be hung higher than would be possible with dark walls and ceiling, for giving the same average illumination on the chosen plane; moreover, greater uniformity is obtained.

With the inverted gas burner unshaded, the number is reduced from 17 in Case 1 to 11 in Case 2. When the ground glass shade is used, the number is reduced from 20 to 13. With the prismatic distributing reflector the reduction is from 10 in the case of a dark-walled room to 9 in a room with light walls and ceiling.

Referring to the paper of Messrs. Lansingh and Rolph, it is to be noted that the reflected light from the ceiling which represents the greater proportion of the increase due to the light color mentioned, has a very marked effect on the uniformity of the illumination throughout the room, the strongest reflection being directed toward the center of the room. This fact is worth note in laying out installations, for lamps may be placed closer to the walls and with more free space in the center than would theoretically be possible unless this fact were taken into consideration. This result will permit of higher illumination values being given to counters, shelves, desks, etc., than has perhaps been generally the case, at no appreciable loss to the lighting of the center of the room.

This condition still further accentuates the necessity of co-operation between architects, builders, and illuminating engineers to prevent waste of light by the use of color schemes of low reflecting value.

It is likely that in practice the total amount of reflection from ceiling and walls may be reduced below the figure assumed and for this reason the lamp giving the best downward distribution of light will prove more efficient.

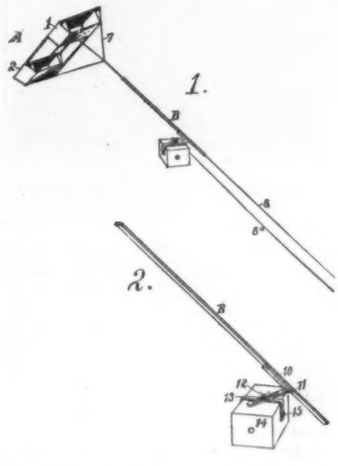
There is, further, the advantage of the major part of the light being direct in the case where the prismatic reflector is used, whereas in the case of the open lamp a very large part of the light falling upon the plane of illumination is complexly diffused. For purely general illumination, the latter case may be desirable, but for any definite work there should be a definite direction to the light so that fairly distinct shadows may be utilized. It is found also that the purely diffused lighting system entails a serious strain upon the eye, there being practically no shadows on which the retina may be directed when fatigued; the light enters the eye from all directions, below as well as above. This is true to a less extent where the illumination is general and largely reflected from walls and ceiling, as in the case of the bare lamp, but is largely reduced by the use of the reflectors for directing the light downward. The character of the surfaces constituting the plane of illumination, of course, has a very marked effect in this regard, a surface largely light-colored reflecting a great deal of light directly into the eye.

In Case 1 and in Case 2 there is given a column showing the consumption of gas per hour per square foot of the plane in question required to give an illumination of 1 foot-candle.

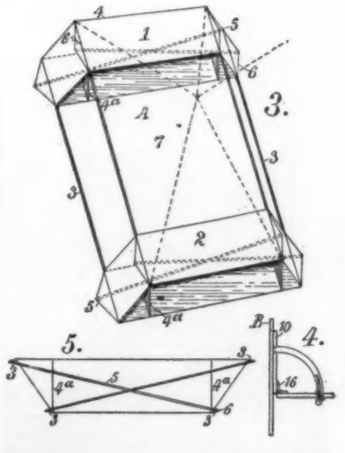
These data may be found useful for rough determinations of the total amount of gas per hour required for lighting any specified area, with a chosen type of burner. The results obtained in this way will not in all cases allow uniform illumination. To obtain this result some variations from the number of lamps determined above would be necessary in cases where a very strong light is concentrated immediately beneath the lamp. In general, however, by a suitable arrangement of the fixtures, fairly uniform results can be obtained with the specified number of burners.

APPARATUS FOR AERIAL PHOTOGRAPHY.*

WE illustrate herewith an apparatus for aerial photography invented by Mr. S. T. Williams. The aeroplane, or kite, has two parts, joined together by struts. Each part contains sails forming a rectangular box,



open at both ends, and having a triangular extension on each side. The upright struts are held apart by cross-stays, which are lashed in position, and are detachable to enable the machine to be rolled up when not in use. When the kite, or aeroplane, is stood on the ground, with the struts in a vertical position, the horizontal plane is a trapezoid, having the angles at each parallel equal. The cord, or wire, which holds the above-described kite, or aeroplane, captive, is also provided with a clamp, which will grip it, and which combines in itself the suspension for the camera, arranged so that the latter can maintain a predetermined angle in relation thereto.



Four struts are held together by cross-stays, and so arranged that when sails are added they form a rectangular box that at top and bottom are open-ended, and this represents in plan a figure composed of four straight lines having two sides parallel to each other, and two sides of equal length joining said parallels, with opposed inclination the one to the other, hereinafter termed a regular trapezoid, the struts being disposed at the angles of the said regular trapezoid.

The cord, or wire, which holds the kite captive is provided with a clamp, fixed to it. The extension from this clamp is arranged to be attached to a camera in such a way that the camera in relation to the clamp may be maintained at any predetermined inclination.

Fig. 1 is a general perspective view. Fig. 2 is an elevation of part of the invention. Fig. 3 shows detail of aeroplane, or kite. Fig. 4 shows detail of adjustable camera-carrying bracket. Fig. 5 is a plan of aeroplane, or kite.

In the illustration, *A* is the aeroplane, or kite, which consists of two parts—an upper portion, or rectangular box, 1, and a similar lower portion, 2. These two parts are held together, preferably, by four upright struts, 3, disposed in the angle of the said upper and lower box-shaped parts, the formation of such parts being oblong, with triangular extensions, representing in plan a regular trapezoid, with the struts at the angles of such regular trapezoid (see Figs. 3 and 5).

The sides, or sails, of the upper and lower rectangular box-shaped extremities are made of canvas, 4, as well as the sides, 4*a*, of the oblong portion, or the equivalent, which is bound or stitched around the struts, 3. In order to keep the struts apart, and so make the aeroplane, or kite, taut and stiff, cross-stays, 5, are used, which are lashed by cords, 6, at both ends to the struts 3.

Guy cords, or ropes, 7, are preferably disposed at the corners or ends of the struts forming the kite or aeroplane, and joined to the cord, wire, or other similar material, 8, which holds the kite captive. Disposed at any convenient and predetermined position on the captive cord 8 is a clamp, *B*, secured by binding or by cleating the said cord 8, and upon this clamp *B* the camera-bracket, 10, is mounted. This bracket is preferably of about, or may be less than, 45 degrees, and is formed with a slot, 11, in its free projecting limb, and a thumb, 12, adapted to slide within this slot. The screw, 12, forms part of the camera-sling, 13, which spans the camera, 14, and in which the latter is pivotally mounted by set-screws, 15 (see Fig. 2).

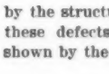
For the purposes of transport, the kite has the cross-stays removable, so that the whole apparatus may be folded up and bundled. When the operator desires to take an aerial view of any particular landscape, he unfurls the kite and adjusts and binds the cross-stays 5 into position, at both top and bottom ends, and adjusts the guy-lines so that the kite is balanced. He then flies the kite, paying out an amount of cord that he may deem necessary to enable him to get the correct altitudes from which to obtain the desired photographic view. He now secures the clamp *B* upon the cord, adjusts the camera to any desired angle in the sling, and secures the sling 13 in the free limb of the bracket 10, paying out now a cord, wire, or tube 8*a*, other than the kite-cord, with which to operate, at a desired moment and elevation, the exposure apparatus of the camera. In order the better to adjust and arrange any predetermined angle, the bracket 10 is provided with a hinge, 16, and provides means for adjusting and fixing the angle of the free limb, such as that shown, which consists of a radial slot and thumb-screw.

If necessary, one or more additional similar kites may be looped upon the cord, at a safe distance from one another.

* English Mechanic and World of Science.

NEW SOLVENT FOR INDIA RUBBER.

THE liquids commonly employed as solvents of India rubber are inflammable, suffocating, and heavy. The symmetrical ethylidene chloride which is represented



by the structural formula $H-\underset{Cl}{\overset{|}{C}}=\underset{Cl}{\overset{|}{C}}-H$ is free from these defects and is also a superior solvent, as is shown by the following table:

	Specific Gravity.	—Percentage Dissolved— Para Rubber.	Borneo Rubber.
Ethylidene chloride..	1.27	99.5	95.9
Carbon tetrachloride.	1.59	75.6	46.4
Chloroform	1.49	74.9	56.8

Cowper-Coles has laid before the British Iron and Steel Institute the results of his successful experiments in the production of iron plates and tubes in a single operation by electrolysis. In the Cowper-Coles process a quantity of cast iron or of iron ore (materials containing ingredients which prevent their employment in the manufacture of high-grade iron or steel can be used) is placed in an acid bath and connected with the positive pole of a dynamo. The negative electrode (if tubes are to be made) is a wooden core covered with a sheet of lead, upon which the iron is deposited by electrolysis. When the tube has attained the desired thickness it is removed and heated for the purpose of melting the lead and extracting the core. Iron plates are made by a similar process. The method is cheaper than that of fusion and rolling, the product is of superior quality, and it is possible to use ores which cannot be employed in the usual methods, to recuperate the iron used in the metallurgy of copper and even, perhaps, to dispense with the mining and cleaning of ore and to apply the process directly to **ore beds** ***in situ***.

BELLINI-TOSI SYSTEM.

A METHOD OF DIRECTING HERTZIAN WAVES.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

WE have already referred to the method which is used by Messrs. Bellini and Tosi for obtaining directed aerial waves in wireless telegraphy. In this article we will describe more recent results obtained by them in experiments carried out between stations located on the channel coast of France, and will explain their new instrument, the radio-goniometer, which is the

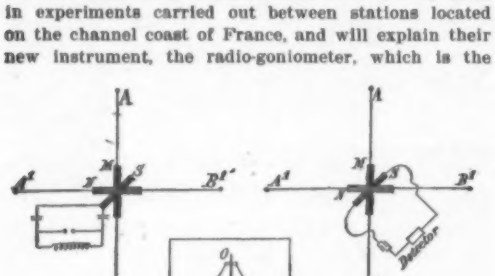


FIG. 2. FIG. 1. FIG. 3.

ARRANGEMENT OF ANTENNÆ AND COILS.

basis of the system. With this instrument it is merely necessary to turn the pointer around a graduated dial in order to sweep around the horizon with the waves, almost as we would do with a searchlight. The waves are thus directed toward the station which is chosen for the purpose, and all other stations lying outside a given angle will therefore not receive the waves.

Ever since wireless telegraphy appeared, there have been made attempts to keep the waves within a certain zone of action. Efforts were made to direct the waves by setting up several antennæ, each sending directed waves to different points, or else by using one antenna and turning it about. The first method is far from being exact because of the limited number of antennæ which can be used. Moreover the working antenna influences the other antennæ to the detriment of the system. The second is objectionable because by turning about the antenna, it cannot be used in practice, due to the lofty mast which is generally employed. One idea of this kind was to mount the antenna on a boat and to turn the boat around. It has been recognized that none of these methods can be applied in practice and in fact we do not hear that this has been done with any success. Some method had to be found in which the aerial is stationary and only the instruments in the station are turned about for directing the waves.

In their Channel coast experiments, Messrs. Bellini and Tosi proved conclusively that this could be done. The basis of their system is the use of a mast circuit which forms a nearly closed geometrical figure. In theory this figure is a narrow rectangle, but they found that for practical purposes they could use a triangle, composed of two wires suspended from each side of a high mast and coming down to the station where they have a slight spread to form the base of the triangle.

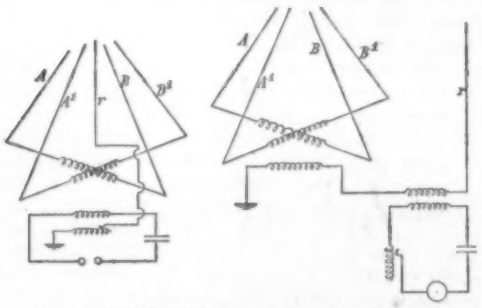
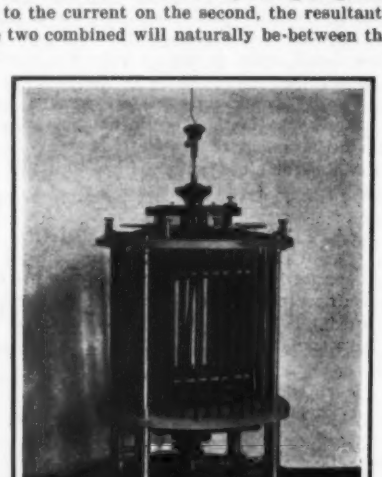


FIG. 4.—TRANSMITTER. FIG. 4A.—RECEIVER.

HOW RADIATIONS IN DEFINITE DIRECTIONS ARE SENT FROM TRANSMITTING TO RECEIVING STATIONS.

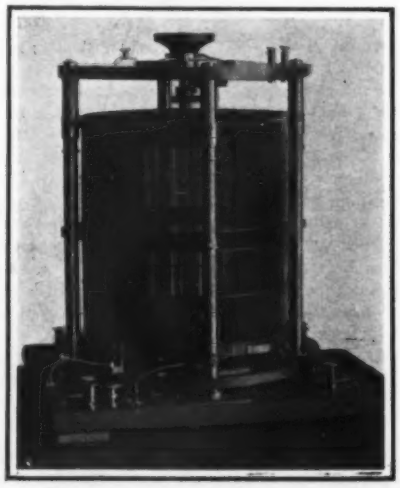
Such a circuit has the property of sending waves principally in its own plane, and in the perpendicular direction there is no radiation whatever. The waves are thus "directed" in a certain measure, to the front and the rear equally and in a fixed direction. We now mount a second triangular antenna on the same mast, but bringing the wires down in the perpendicular direction from the first; that is, where the base of the first triangle is placed north and south the base of the second one is mounted east and west, and we have two intersecting triangles. The first triangle tends to radiate the waves north and south, and the second one east-west. Should the first triangle act alone the waves are directed north-south, but giving an equal value to the current on the second, the resultant effect of the two combined will naturally be between the two,



RADIO GONIOMETER OF THE BELLINI-TOSI SYSTEM.

or northeast-southwest. When on the contrary the current predominates in No. 1, the effect is turned in this direction, and when it is stronger in No. 2 we have an angle lying near the latter's direction. We now require an instrument which gradually increases the curent in one triangle and lessens it in the other, in order to obtain all the directions around the circle. This is carried out by the present instrument, the radio-goniometer, as will be further noted. The final step is to get rid of the counter radiation (the south, for instance) so that we radiate only to the north. This is done by using a simple vertical antenna in the middle of the triangles, which acts to oppose or cut off all the waves in the reverse direction, so that in any given case we send waves only from the front. By turning the radio-goniometer we now send out what may be likened to a beam of waves.

The triangular antennæ are both mounted on the mast *R* (Fig. 1), each being composed of the descending wires *OA*, *OB*, joined by the base wire *AB*. In the circuit *AB* are placed the station instruments. This will be observed in Fig. 2, where *AB* is the base of the first antenna and A_1 B_1 the base of second antenna, these two crossing at right angles. In the center is the radio-goniometer, which contains two fixed coils. One of the coils, *M*, corresponds to the first antenna and the other, *N*, to the second. A third coil, *S*,



RADIO-GONIOMETER OF THE RECEIVING STATION.

placed in the center can turn about on its axis, and is connected to the exciting circuit. Placing *S* parallel to the fixed coil *M*, we excite only the antenna *AB*, and turning it parallel to *N* we excite only A_1 B_1. When we place it as shown here at 45 deg., we excite both antennæ equally, and the waves will be sent out also at 45 deg. owing to the resultant effect of the two antennæ. By turning about the coil *S* the direction of the waves follows it all around the circle.

At the receiving post we use the second form of radio-goniometer, which works on the same principle, but the instrument is designed somewhat differently for these requirements. The receiving post is shown in Fig. 3, with the crossing antennæ *AB*, A_1 B_1, and the three coils of the radio-goniometer. The effect is analogous to that of the first station. If the first post is in the direction of *A B*, this circuit receives a current and this induces a current in the movable coil *S*. When *S* is turned parallel to *A B* we find the maximum effect in the detector and less in the other directions, down to zero. When the first post lies in the direction of A_1 B_1, we have the greatest effect by placing *S* parallel to the latter. Should the direction be between the two, the waves are found strongest when *S* is placed at 45 deg., and so on for all the points on the horizon. We thus place the movable coil so as to receive from the desired post and not from the others.

This applies to a system which radiates out in two directions, north and south, for instance, at the same time. To cut off the south waves we use a vertical wire *r* (Figs. 4 and 4a) mounted on the mast. It gives off waves in a circle, as usual. Working with the antenna *A B* (north-south), when *r* has an equal power it will be seen that the waves from *r* will be added on the north side and subtracted on the south side, so that the combination will give only north-directed waves. The same applies to the waves sent out from *A B* and *A′ B′* around the horizon, and the back waves are always cut off by the action of *r*. We thus have the means of sending the waves strictly in one

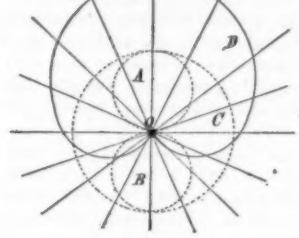


FIG. 6.

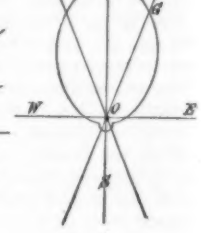


FIG. 5.

Fig. 5.—Measurement of energy given off by the 3-antennæ or single-direction system (*A B*, *A* B_1 and *r*). Most of effect is in one direction or *O N* as seen at *F*; at a small angle the effect rapidly falls off, at *G* for instance. A station placed at *G* would therefore not receive the waves sufficiently.

Fig. 6.—*O*=center of radiation, *A* and *B*, strength of radiations in the horizon for different angles, using double-direction system. *C*= strength of radiation from the vertical mast *r*; therefore when we use *r* and *A B*, A_1 B_1 together we have the radiation values as seen in the curve *D*. Maximum effect is at *E*.

direction. Experiments were made between Dieppe as a center, working to Havre and Barfleur, on the Channel coast. Messages could be sent to Havre without these being heard at Barfleur, the angle being 23 deg.

By observing the maximum effect in the detector, we can locate the direction of a distant station within 1 degree on the horizon. Using two stations on the coast spaced at a known distance apart, we can find the position of a vessel at sea. Post No. 1 finds the angle on the horizon and Post No. 2 does the same. Then by triangulation we have the distance of the vessel. When the vessel moves, we repeat the observations at stated intervals and thus obtain the route and the speed of the vessel.

Where two vessels send messages to a station at the same time it is difficult and often impossible to receive the messages. This can be avoided by the directive method. In general, we have the following advantages in the system of Messrs. Bellini and Tosi: We can find the direction and position of a vessel in distress and thus see the route to be followed by a rescuing vessel. We also see the position, speed, and route of friend's or enemy's fleet and can take the needed decisions. Friends will receive our signals, while the enemy cannot take them, and thus we can remain concealed from the enemy. The movements of the enemy's army can be followed when stationary or on the march. We can communicate with friends without the enemy's being able to set up disturbing waves so as to prevent this. The system can be set up on the coast in the same manner as a lighthouse so as to indicate a dangerous zone when the fog prevents the light from being seen.

A NOVEL RAILWAY TICKET PRINTER.

A MACHINE WHICH DOES AWAY WITH LARGE STOCKS OF TICKETS.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

For some time past the German government has been practically testing a new system of issuing railway tickets at the Cologne Central Station of the State railway system. This device, which dispenses with the necessity of retaining large stocks of printed tickets for each of the stations served from that center, possesses many ingenious features, the most important of which is the printing of the ticket upon demand, and an automatic double record of each sale effected, for the purpose of checking the receipts.

Not only does it supersede an arrangement whereby supplies of tickets are pigeonholed in racks ready for demand, but it dispenses with elaborate bookkeeping and counter checking, which now has to be resorted to in order to prevent fraud, theft, and misuse.

By means of the new system the ticket is printed only on demand, and the only stock required is an adequate supply of blanks. The apparatus is very simple both in its design and operation. Its general appearance may be clearly gathered from the accompanying illustrations. There are a number of small printing plates or electros of the impression to be printed on the face of the ticket, one for every station upon the system, disposed in long troughs or racks. These plates stand edgewise and in such a manner that they cannot be withdrawn from their position except by the printing appliance itself.

At the back of the machine is a polygonal-shaped roller, carrying on each flat surface an index of the names of the stations, printed in alphabetical order, and the positions of the electros in the racks correspond with this scale. This roller is rotated to bring a required list of names into position (since it is obvious that upon an extensive railway all the names cannot be imprinted on one face of the roller) and the distribution of the electros within the rack coincides with the list of station names carried on the roller index. The printing apparatus itself comprises a small carriage fitted with a handle for its manipulation, together with a secret recording or checking equipment.

When a traveler demands a ticket for a certain station, the carriage is moved along its path until its pointer comes opposite the name of the requisite destination on the index roller. The operator then slips a blank into the printing device, turns the handle, and the ticket is discharged through a slot fully printed, while a dual record of the operation is obtained upon the continuous roll of paper locked within the printer. By the actuation of the handle the electro required is withdrawn from its normal position in the rack, for imprinting the blank, after which it is returned to its place. The imprint upon the ticket can be whatever is desired by the exigencies of the railway. That in operation at Cologne prints the names of the stations of departure and arrival, the route, baggage district, class of carriage, the date of issue, fare, and a consecutive number. Any class of ticket can be printed, while the recording of the fare upon the continuous roll of the checking mechanism is an absolutely correct record of the transaction and an infallible check upon the operator.

It is absolutely impossible for any ticket to be printed without the fact being registered upon the counterfoil. Similarly, it is impossible to withdraw an electro from its position in the machine for dishonest use.

At the commencement of the day's work the head operator inserts the batch of electros for that day's service, and the numbering, which records in rotation from 0001 to 9999, is set, together with the paper counterfoil. The machine is then locked, and any attempt to tamper with the mechanism is at once observable. At the conclusion of the day's work or the term of duty for the day of that particular operator, the paper record can be withdrawn from the machine. By casting up the columns and counting the cash received for tickets, he can balance his account forthwith. No other booking operation is requisite. Should a ticket be erroneously printed, he has simply to attach it to his sheet and then explain the difference between the counterfoil total and cash receipts. Moreover, the machine is so simple and easy to operate, that it can be tended by a boy or girl.

Another advantage is that it acts as a complete safeguard against theft. The blanks are obviously valueless until passed through the printing machine. Should the operator for any reason have to leave his office for a few minutes, he can easily lock the apparatus, so that it cannot possibly be used in his temporary absence. Inaccuracies are out of the question, and discrepancies in debit and credit are directly attributable to the operator, while the dual checking in the machine itself completes the operation. Owing to the fact that the tickets are only printed as required, it is impossible for the supply of any particular station to be exhausted, as is possible with existing arrangements.

The machine has also proved itself to be an excellent

A RAILWAY TICKET PRINTING MACHINE FOR PRINTING TICKETS ON DEMAND.

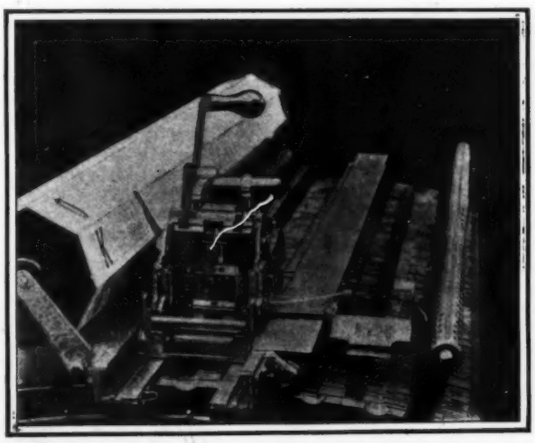
View showing index scale, carriage, and racks of printing plates.

time and labor saver. At Cologne station, owing to the eminent success of the first machine, the administration installed three others. These are in constant use for twenty-two hours every day, being worked from 4 A. M. to 2 A. M., in three shifts, one official to each machine. Under the former system double the staff was necessary. Though the system may appear somewhat involved, once the operator has mastered its manipulation he can issue the tickets very rapidly. Recently one operator at Cologne issued 500 tickets to various stations in an hour, which is more than twice as many as could be issued in the same time with tickets already printed.

The flexibility of the system has also impressed railway officials who have inspected its operation at Cologne. The apparatus at this station is designed for service to 1,300 stations, but the machine can be adapted to any number with facility. At busy termini of extensive stations the service can be divided into sections, and one machine appointed for duty to each, thereby simplifying and facilitating the work. To the traveling public the machine has proved a decided boon, as the period of waiting for a ticket is reduced to the minimum, as it is as easy to supply a ticket for a point seldom desired as one in constant demand. Being only a small machine, measuring about 3 feet in length by 4 feet in height and some 2 feet wide, it occupies but little space, and can be set in a convenient position beside the ticket-office window, so that the space required for this part of the railway administration service is reduced to the minimum.

Another important point is the appreciable economy that is possible therewith. The ticket-printing bill is entirely saved. Just what this signifies is shown that at one place in Germany, where a supply of printed tickets cost about $1,750, the same number of blanks entails an outlay of only $100.

The system is applicable to any purpose for which tickets are required, such as theaters, and has been introduced into the government abattoirs of Germany. Here again it has simplified bookkeeping operations to a marked degree. In this case a ticket is not issued for each animal, but for any number up to 10, and the tickets vary in color to meet the special requirements prevailing. The clerk exchanges the ticket for the cash received, and simultaneously a double record of the operation is secured on the control roll of paper. Upon conclusion of the day's work the apparatus is locked up and the clerk tears off his double record of the cash he has received, which indicates the number of animals, together with their value, that has passed through his hands. The accountant checks instantly the cash received and the records. No further booking is required. The double record of the transactions is pasted into a book with the consecutive numbering of the tickets in rotation. Then if at any time it is desired to carry out investigation for any purpose, it can be easily and readily accomplished by consulting this record, while the preparation of statistics is also rendered a much easier task.



TOP OF PRINTING MACHINE, SHOWING INTERIOR OF PRINTING CARRIAGE WITH PLATE IN POSITION READY FOR PRINTING.

THE MORTALITY RATE IN DUSTY TRADES.

FREDERICK L. HOFFMAN, statistician of the Prudential Insurance Company, Newark, N. J., has contributed an article to the bulletin of the Department of Commerce and Labor on the mortality from consumption in dusty trades. The number of occupations considered is 42, divided into four groups, according to the exposure of the workers from metallic, mineral, vegetable fiber or animal and mixed fiber dust.

The article states that of the deaths from all causes among males 15 years old and more in the United States 14.8 per cent were from consumption. According to industrial insurance experience, the ratios were 36.9 per cent for occupations exposed to metallic dust, 28.6 per cent for those exposed to mineral dust, 24.8 per cent among those exposed to vegetable fiber dust, and 32.1 per cent for those exposed to animal or mixed fiber dust.

The occupation showing the highest percentage of mortality was that of grinders, among whom 49.2 per cent were from consumption. In each occupation group the highest mortality from consumption was among persons between the ages of 25 and 34, the proportion of deaths between those years being 57.2 per cent in occupations exposed to metallic dust, 47.6 per cent in those exposed to mineral dust, 53.9 per cent in those exposed to vegetable fiber dust, and 53.3 per cent in those exposed to animal and mixed fiber dust, as compared with 31.3 per cent for all males in the registration area.

It is the opinion of the author that by intelligent

methods of ventilation and dust removal the consumption death rate among wage earners can be reduced from 2.2 per 1,000, the rate based on the number of deaths among gainfully employed persons 10 years of age and over in the registration States in 1900, to 1.5 per 1,000, the average rate for 200 small cities, as shown in the mortality statistics of the United States census for 1901 to 1905.

Such a reduction, the author estimates, would result in an annual saving of 22,238 human lives and would add 15.4 years of life for every death from consumption avoided by rational conditions of industrial life. Such a gain would represent a total of 342,465 years of lifetime, and by so much the efficiency of the American nation would be increased.—Iron Age.

SOME USEFUL LESSONS OF LIMEWATER.

A FEW CHEMICAL FACTS FOR THE ENGINEER.

BY CHARLES S. PALMER.

ALL that we have studied thus far is only an introduction to what that barrel of quicklime has to tell. We have seen that lime-like substances are found in hard water and that, sometimes, it is one of these same lime-like things which may be used to overcome this hardness; as though one should make one hand wash the other; or, following the old proverb, healing by "a hair of the dog that bit him." But this subject of hard water, while very real and practical, is not a separate thing by itself; it is connected with many other chemical facts and theories. We will make short excursions into some of these other fields, such as that of fire or water, or acids or alkalies.

FIRE.

In making our clearing before our imaginary cabin home, in the forest of ignorance and prejudice, one of the first things which we should know something about is the air, or the atmosphere, as it is also called. We know that the air has everything to do with burning, for if we want to make a fire burn in a stove or furnace all that is necessary is to keep the grate free from ashes, supply it with fuel, light it and give it free draft. Indeed, in some forms of power maker one can almost control the engine by regulating the doors and dampers. So it is almost self-evident that burning, in the common meaning, is dependent on the air draft.

Moreover, when coal or fuel burns there is some great change in the fuel. Most of it goes up the stack, except some 5 or 10, or, perhaps, 15 or 20 per cent of ashes; but usually from 80 to 90 per cent of the fuel vanishes in the work of furnishing heat and power. If one should look only at the fuel and the remaining ashes he would suppose that burning is a subtraction; and there was once common among scientific men a theory which called itself "phlogiston," that is, "burn stuff," and which supposed that burning is a subtraction, because they looked only at the fuel and ashes. But if we look with one eye at the fuel and the ashes and save the other eye for the waste gases which go up the chimney, then we find that burning is an addition, and not a small addition, but a great addition. This is proved by burning fuel in closed apparatus and weighing everything which comes off it. In this way it is found that one ton of hard coal will send up the chimney, when well burned, between three and four tons of burnt gas, to say nothing of wasting heat on some nine or ten tons of a gas (nitrogen) which is in the air as neutral "filler."

If your attention has never been called to these curious facts, you have a good right to be skeptical as to the correctness of the figures. They are only general, but they are approximately correct; and you begin to think that our eyes must be half blind to let such vast quantities of substances slip by us unnoticed. There are many ways of getting at these interesting things, but one of the easiest ways is to ask this simple question: Is the air about us composed of one thing, or of several things? You have heard all your life that the air is mostly made up of the two gases, nitrogen and oxygen; but if you have not taken this statement in the forceps of your careful attention, if you have not tested this statement with your own chemical apparatus, you can have but a faint notion of the wonderful meaning and the good business value which lie hidden behind the simple statement that the air is made up of nitrogen and oxygen. You know that there is more of the nitrogen than the oxygen, and yet that the oxygen is the active thing as far as burning is concerned; but you need to prove at least a part of this for yourself, in order to see what the fact is worth to you.

TWO THINGS IN THE AIR.

Take a common wash or dish pan, as shown in Figs. 1 and 2. By the way, you will be flattered to know that your wash dish is serving for what the books call a "pneumatic trough"; which means a contrivance for handling gases, a simple but great invention. Put an inch or two of common water into the dish. Get a wide-mouthed jar, say a common fruit jar. Find a wide, flat cork, which will easily pass through the mouth of the jar, without touching the sides, and float the cork on the water in the wash dish. Now find a little saucer-shaped dish to ride on the cork and to hold some easily combustible stuff, such as match ends, sulphur or phosphorus. The cork must lie flat and well balanced with its cargo of stuff to burn; and sometimes it will be more stable if the wider end of the cork is at the bottom. You will find

FIG. 1.

that you must get this point well fixed, as you have got to place the jar mouth downward over the cork and its cargo without disturbing the latter. Any saucer-shaped piece of tin or iron, as the round cover of a spice box, will do for the little dish; sometimes the saucers and plates of a doll's tea set serve first rate for such purposes, or the little dishes in a common box of water paints. You want to get the cork and its load well balanced, so you can slip the wide-mouthed bottle down over the cork. Then light the phosphorus or match ends, or what stands for your quick burner, and neatly put the bottle mouth downward into the water and over the burning cargo on the floating cork. As it burns, there will be an escape of several bubbles of air from the bottle, and you can explain this by the sudden heating of the air shut up in the bottle. But pretty soon the fire in the dish on the cork will burn more slowly, and finally it will go out. Meanwhile the cork, with its cargo, has risen up and into the jar, as the water absorbs and cools the air inside the jar.

Now note the air in the inside of the jar or bottle. It is thick with smoke and fumes; but these will be partly absorbed by the water in the bottle, for the water will rise part way up the side of the jar or bottle (Fig. 2). You want to perform this experiment over and over again, so you will get rather expert in handling what will soon seem clear and simple to you. You will note that if you use nearly pure phosphorus from match ends, or with some sulphur from eight-day matches, or with some powdered sulphur or brimstone scattered on, you will get more absorption of the fumes remaining in the jar after the burning. When you use wood or paper, coaxing it with a few drops of kerosene, you will not get as much absorption of the burnt fumes by the water. But in every case, with the burning of phosphorus you will get an absorption of the air in the bottle by the burning amounting to from one-fifth to one-third. The correct figure is about one-fifth; but you may drive off too much air at the start from the expansion from heating, before the real burning has gone very far; and this error in the experiment will show up as an apparent absorption of the original air greater than the real absorption and disappearance of the air in the bottle.

FIG. 2.

There are several sides to this experiment, and we will mention them here, so that you can be on the lookout for them:

First, the strong burning of the stuff in the little saucer, and the placing of the jar over this.

Second, as soon as the fire has gone out in the saucer and the water in the jar has finished absorbing the fumes from the burning, lift the jar quickly out of the water, first slipping a piece of cardboard over the mouth to keep the water that is in it from flowing out. Shake violently, using the cardboard cover, and set the jar right side up on the table. Note the amount of absorption of the original air in the jar.

Third, light a splinter of wood and thrust it quickly down into the air left in the upper part of the jar; the splinter is put out, as anybody should know it would be, because if the fire of phosphorus went out, wood or paper would not burn well in this same residual air. All the same, it is not a foolish thing to do, to test this same residual air with your splinter of wood. It sets you to thinking what it all means and you begin to note that there must be different kinds of gas as regards their ability to help burning. The gas oxygen that has gone off (it has gone into the water) helped the burning, and it amounted to only about one-fifth by volume of the whole air. The part of the air that is left will not help common burning, although it makes up some four-fifths by volume of the air; this remaining part is nearly all nitrogen. Just to set your mind at rest, you may like to know that there are three other things in the air in small quantities. These are some water vapor, some of your old friend carbonic-acid gas and a strange newcomer, called argon, the "lazy element," because it does not do anything but exist; that is, it does not make any definite compound with anything, but sometimes pretends to be like nitrogen as it is found in the air, about one part in a hundred by volume.

Fourth, put some litmus into the water at the bottom of the jar and note the action. Of course, you know enough by this time never to take one piece of litmus paper, nor one color, but two pieces; or, at least, one piece colored red at one end and blue at the other. You can take a bit of red litmus and let one-half touch a piece of soap to blue one-half. With both red and blue litmus you can catch both alkalies and acids. You will find that the water in the bottom of your jar turns the litmus red; that means that the burning has made something which went into the water and which has acid properties. If you used mostly phosphorus then the burning of the phosphorus has made one kind of phosphoric acid. If you used mostly sulphur in burning in the little dish on the cork, then the burning mostly made sulphurous acid, with some sulphuric acid. But in both cases, the burning with the oxygen of the air made things that are essentially acids. It was the great French chemist Lavoisier who found this out some hundred and forty or fifty years ago, about the time of the Revolutionary war; he showed that burning was an addition, and that the adding of the "burn-helping" gas (oxygen) in the air to the things burnt, as a rule, makes acids (or acid anhydrides, the acids minus water but willing to drink themselves to acids proper); and so Lavoisier called the gas that helps to do all this "the acid maker," which meaning is safely hidden behind the parts of the Greek makeup, "oxy-gen." You will find out later that this claim of oxygen to make all acids, is not quite exact, but that there are acids which have no oxygen in them; but

in every such case the acids have something which plays proxy for oxygen, so that in its broadest sense the name "oxygen," "acid maker," is not so bad for the "burn helper" in the air.

REPEAT THE EXPERIMENT OFTEN.

You must try this fundamental experiment of attacking the composition of the air over and over again and in every shape and method that your ingenuity can devise. Perhaps you can get some of the pure phosphorus to use, the kind that comes in yellow sticks and which must be kept under water to save it from burning up; or perhaps you can get a pinch of the so-called "red" phosphorus, a dark brownish-red powder, which is real phosphorus baked in a close vessel until it goes temporarily into this curious, sleepy form where it does not have to be kept under water to save it from burning; perhaps you can get some of this, to put in your little dish; but, whatever you do use, make it burn and make it take out all of the active oxygen from the air that it will, about one-fifth by volume at any rate. Usually you will get a larger apparent absorption, due to the aforesaid escape of some bubbles by heating.

You must keep your eye fixed on the several points: The good burning; the closing-in of the little saucer by the inverting of the jar; the absorption of part of the air in the jar and the testing of the remaining air; the testing of the water in the bottom of the jar. It all makes a part of the story of the composition of the air, but you will wonder how our friend limewater can help us out here. Well, that is an interesting question; and, in this chapter, we can only begin to show how limewater may have a great deal to do with the problems of burning.

Your thoughts will run somewhat as follows: It is all right to test such things as sulphur and phosphorus and match ends; but common coal is the thing which makes the bulk of the fuel burnt, and we want to see what the air does to that, and how it does it.

The point which we are going to study is this: that coal burns first to carbon monoxide, CO, and this burns further to carbon dioxide, your friend carbonic-acid gas, CO_2, or carbonic anhydride, the anhydride of true carbonic acid proper, H_2CO_3. Now the acids of phosphorus and sulphur and those strong-smelling things made from burning in the air, are readily absorbed by water; and they readily turn litmus red. But carbonic-acid gas is only feebly absorbed by water; it has not much taste and it does not act strongly on litmus; and so we are up against the question of trying to prove that when coal, or carbon, burns in the air, it does make its own form of acid, or acid anhydride, just as sulphur and phosphorus make theirs. You can begin to see how we are going to do this with the help of limewater; for you have already sucked the gases from glowing coal through some limewater, and you are fairly familiar with the acid properties of the gas from burning coal. But that special point will wait for another lesson; we want to get this point clinched, of the approximate amount of active "burn helper," oxygen, in the air.

There are one or two questions which may come up to your mind at this time. One of them is this: What would happen if the air were pure oxygen? That is an interesting question, and you will make some experiments later with pure oxygen to show what would happen. But there are two forms to that question. One form is, what would happen if the nitrogen were taken out from the air and only the oxygen were left? That is one thing, but it would be quite another affair if the nitrogen were taken out from the air, and if its place were taken by so much more oxygen; that would be a condition of frightful possibilities, as you will see when you come to make pure oxygen.

One more question that I want you to think over between now and the reading of the next lesson is this: Why do you have to *light* a fire? Why doesn't it light itself? There is the fuel, there is the air, which you cannot see, but which you can feel, and it is waiting to take hold of your coal. But why does it wait until you kindle it, with all sorts of coaxing, from the match, through the shavings or paper, through the kindling wood, to the hard fuel; why all this preparation for what seems all ready to take place of and by itself? This question is worth some attention, the right answer will open your eyes to some things which no one can see, but which we must all believe to be true; it is the story of the chemical units, noted by those initial letters, and the groups into which those chemical units unite, groups which make up all kinds of material things which you see and feel every day. You are getting nearer the top of one of the foothills of science, and one of these days you will see the main range, and you can see all this from the window of your boiler room.—Power.

A NEW METHOD OF HOUSEKEEPING.

THE FICK APARTMENT HOUSE OF COPENHAGEN.

WHEN the "home," as it now exists, is divested of the traditional glamor with which our fancy has clothed it, and regarded with a dispassionate and objectively seeing eye, its naked cheerlessness becomes appalling.

Yet housekeeping has been undergoing reform and improvement ever since the beginning of specialized industry. At first the family hearth was the center of all the industries which have since become specialized, and have been removed to factories. The removal of each class of work—soapmaking, brewing, baking, weaving, etc.—marked an advance in housekeeping. Now only four classes are left—laundry work (and this is fast going), housekeeping, cooking, and the care and training of children.

The inefficiency and unhygienic character of the usual methods of housekeeping are obvious. Much of the dust dislodged by the broom settles down again, after poisoning the air for hours. Carpets, curtains, and the upholstery and carved decorations of furniture are never free from dust.

No diligence in housekeeping can keep the house clean so long as it is heated with coal and lighted with gas or kerosene. The progress of applied science has given us electric light, steam heat, ventilating apparatus, and pneumatic dust collectors, but these blessings are enjoyed only by the rich and can not be introduced into the ordinary small home.

The defects of home cooking are apparent to every physician. Almost every other art has become highly specialized, but in the preparation of food we cling tentatively to amateur methods.

The same is true of the care of children, so that the mother is expected to be, as Charlotte Perkins Gilman says, an embryo combination of cook, nurse, laundress, chambermaid, waitress, governess, and housekeeper—Jack of all trades and master of none.

An attempt to reform this state of things has been made by Otto Fick, who established an apartment house of a novel type in Copenhagen in 1904. The apartments—twenty-five in number and containing from three to five rooms each—are rented unfurnished, so that each family can furnish its home in accordance with its own tastes and requirements. Each apartment has a kitchenette with a gas stove and a bathroom, supplied with hot water day and night. Electric light and central steam heating are included in the equipment, and each apartment is connected by telephone with the general kitchen, and also with the public telephone system. Meals are prepared in the general kitchen and sent up to each apartment by means of an electric dumb-waiter.

Privacy is as complete as in an apartment house of the usual type. The only commercial feature is the centralization and specialization of every task of housekeeping—cleaning, ventilation, lighting, heating, and preparation of food—so that the tenants are entirely relieved of the burdens of marketing, making fires, cooking, sewing, dishwashing, etc.

Luncheon is served in the apartments from ten to twelve, and neatly packed luncheons are provided for school children and others who desire them. Dinner is served in the afternoon, according to Copenhagen custom, and tea until ten in the evening.

The menu is so extensive and varied that monotony can be easily avoided, and the general kitchen has a list of the preferences, and particularly of the aversions, of every family, in which it is gravely set down that one family is never to be served with mushrooms, a second with cabbage, a third with rice pudding, etc. Individual, as well as family, preferences are respected.

Dishes, plates, cups, etc., of the so-called "unbreakable" ware are furnished by the management, but each family may provide its own table ware and have it washed in the general kitchen, without, however, any guarantee against breakage. Laundry work, extra service and meals for occasional guests are furnished at low rates.

Cheapness, indeed, is the guiding principle, and cheapness combined with excellence is attainable only with the aid of centralized housekeeping. The kitchens and other service rooms in the basement are equipped with the most approved apparatus, and the food and other supplies are abundant and of the best quality.

The annual charges for rent, heat, light, baths, food, and service, including pneumatic "sweeping," window cleaning, and even shoe polishing, are about:

For 2 adults occupying a 3-room apartment..	$420
For 2 adults occupying a 4-room apartment..	550
For 3 adults occupying a 4-room apartment..	735
For 4 adults occupying a 4-room apartment..	855
For 2 adults occupying a 5-room apartment..	655
For 3 adults occupying a 5-room apartment..	795
For 4 adults occupying a 5-room apartment..	930

Small additional charges are made for children and servants.

This first centralized apartment house has proved so successful that others are projected. Fick also purposes to erect a house with large general playrooms for school children and for small children. Nurses will also be provided so that mothers who have occupations away from home will be able to leave their little ones in safe keeping.

Another event of the Fick system is that it settles the servant question to the advantage of both employer and employed. Much of the work of the centralized household is performed by machines and the rest is skilled labor with definite hours of work. When housekeeping is thus raised to the rank of a specialized industry it will attract workers of a more intelligent class who now very justifiably refuse to work sixteen or eighteen hours a day.

There are other advantages, both economic and social. Under the present system a house is unattainable by an unmarried man or woman, yet the cost and burden of housekeeping act as preventives of marriage. The system is very elastic and allows of apartments of two rooms, or even one room, and of general dining rooms, reading rooms, etc.

Finally, the lifting of the burden of housework makes possible a reform in child culture. At present only the children of the wealthiest classes enjoy anything like proper care and training. All other children are sacrificed to the foolish tradition which regards the mother as the natural teacher and the home as the best school. Mother love is an instinct, and it implies no pedagogic ability, as daily experience proves. Education is a function of society, and it should be performed by persons of fitting character and ability, who have been prepared for the task by study, not by procreation. The fully developed cooperative house will have "crèches," playrooms, and open-air playgrounds and gymnasiums on the roof, presided over by skilled nurses and teachers.—Umschau.

SENSE OF SMELL IN FLIES.

By ALEX. HILL.

BY far the most efficient fly destroyer with which I am acquainted is a dilute solution of formaldehyde. If two teaspoonfuls of formalin (40 per cent formaldehyde) be added to a soup-plate filled with water, flies go to it, one after the other, to drink, especially in the early afternoon. Some die in the water; many fall in the immediate neighborhood of the plate; others succumb on window sill or floor. As a result of leaving a single plateful of the solution on the kitchen table (I am writing in the south of France) hundreds of dead flies are each day swept up from the floor. Formalin water is free from the gruesome associations of fly-papers and other traps which hold their struggling victims. It may even be turned to ornamental uses. A wire cage placed in the center of the dish may be crowned with flowers, which flourish equally as well, with some slight but interesting changes in tint, in dilute formalin as in pure water. The solution neither attracts nor repels flies. Two similar dishes placed side by side, the one containing pure water and the other formalin, are visited, so far as one can judge, with equal frequency. It is somewhat strange that so small a dose proves fatal when taken into the fly's alimentary canal. I find that, to free a room from flies by vaporizing formalin, the air must be rendered quite irrespirable by a human being. The room needs to be amply ventilated before one ventures into it.

The interest which attaches to this observation, that flies will drink a solution of formaldehyde, lies in the proof which it affords that the mechanism of their sense of smell is similar to our own. No volatile body the density of which is not greater than that of air is a stimulant of our olfactory membrane. Formaldehyde, H.COH, has a density of 15 only. Playing in paradoxes, one might say that it undoubtedly has a malignant odor, but we cannot smell it. If the nose be placed close to a vessel containing a dilute solution of formalin a scent is recognizable, but this I take to be due (a chemist will correct me) to impurities present in the commercial product. Yet I find that when I sit

within a yard of it my eyes begin to smart. In this respect, however, I am, I know, exceptionally sensitive. I cannot dissect specimens preserved in formalin until after they have been long soaked in water and spirit frequently changed. Once, when conducting a *viva voce* examination with the aid of formalin preparations, I developed so acute and painful, although happily transient, an attack of conjunctivitis as made it impossible for me to attend the examinees' meeting. The fact that so deleterious a volatile body as formaldehyde does not appeal to our sense of smell would seem to confirm the only theory of the physics of olfaction at present plausible, though far from comprehensible, namely, that which attributes to the hairs of the cells of the olfactory membrane the capacity of responding to the alterations in the vibration frequency or amplitude of molecules of air which are caused by the presence among them of heavier molecules.—Nature.

AN AUTOMATIC GATE FOR CROSSINGS.

A DEVICE THAT TAKES THE PLACE OF HAND-OPERATED GATES.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

A NEW device for operating the protecting bars of grade crossings has been in use upon one of the Swiss electric railroads, the Montreux-Bernese Oberland line, for some time past, and it has given very good results. What is desired in the present case is to secure an electrically operated mechanism which will protect the crossing at the time when the train passes, by lowering a bar on either side of the track and across the road. This bar is similar in form to the hand-operated bars which are now used, being from 15 to 30 feet long, and it is pivoted at one end inside a small cabin which contains the mechanism. A corresponding bar on the other side of the track is likewise pivoted upon a simple timber support, and is connected with a drum placed on the first bar so that the movement of the first bar serves to operate the second one simultaneously. The raising and lowering mechanism is worked by an electric motor, and the current is thrown on to the motor when the train passes along, by means of a suitable electric contact device which is operated by the trolley of the car. Thus when the train comes to a point just before the grade-crossing, the protecting bar on each side of the track is lowered, this action being completed before the train has reached the crossing. After the train passes, the current is cut off from the motor and the bars then resume their former position, being lifted up by means of a counterweight.

The essential features of the automatic device will be noticed in the diagram. A channel bar *A* sunk upright in the ground serves to uphold the entire apparatus. On top of this bar is mounted a bracket *B* which carries a pivot *C*, and upon the latter turns the protecting bar of the track, *D*. This latter is made of an iron beam *E* on the end of which is fixed the wooden bar *F*. On the rear end of the swinging bar is a counterweight *G* which is formed of a cast-iron frame designed to act as a weight in itself and if need be to receive one or more extra weights which are placed in the frame in order to balance the bar.

On the top of the frame is mounted an electric motor *H* which is of small size, about 1/10 horse-power, and thus takes but little power to run it. The motor is supplied with current from the contact device of the track. From a pinion *I* on the motor shaft is driven a gear *J*, which is mounted on a countershaft. Integral with the gear wheel is a double or stepped drum *K*. The reduced or smaller part, also a portion of the large part, is formed with a spiral groove in which is wound a steel cable *L*. In the first or raised position, the main bar occupies the position shown by the dotted lines, with the counterweight at the bottom. One

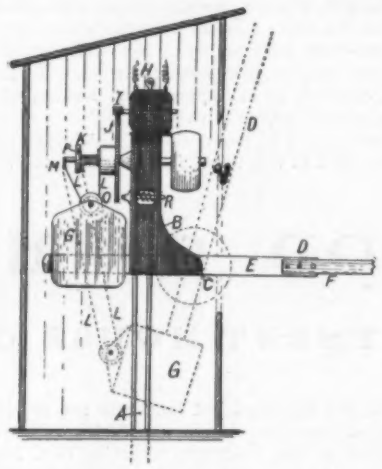


DIAGRAM OF THE APPARATUS FOR OPERATING THE GATE.

end of the steel cable is permanently fixed at *M*, and it passes thence around a sheave *O* on the counterweight, returning to the cable drum. It is not, however, fixed directly to the drum, but it is found advantageous to fix it to the end of a lever *P* which is mounted on a disk at the outer end of the drum.

The operation of the device is as follows: When the train approaches the crossing it completes the circuit of the motor by means of the trolley and thus causes the cable drum to revolve, the cable being in the position shown in the dotted lines. The lever *P* is first drawn down, bringing the end of the cable upon the drum, and the cable then commences to wind upon the drum. This causes the main bar to be brought slowly into the horizontal position, the action taking about 20 seconds. In order to prevent a sudden shock when the bar arrives at the end of its course, the large part of the cable drum is used, and as the cable commences to wind upon the larger step the resistance becomes much greater, causing the motor to be slowed down from this cause and retarding the movement of the bar, avoiding any jarring when the bar comes to the horizontal. As the current remains on the motor while the train is passing, the bar stays in the closed position. When the train moves away and the current is cut off, the counterweight acts to raise the bar. As the cable is now wound upon the large end of the drum, the action of the descending weight causes a great acceleration of the revolving part of the motor, which causes the bar to lift up much more quickly than it descended, and this action requires but 7 seconds. The roadway is thus cleared at once, which is an advantage.

The cable-drum and gear are mounted upon a threaded shaft in such a way that when the cable unrolls the drum is moved toward the right at the same time. This brings the rim of the large gear into contact with a spring-brake *R*, and before the bar reaches the top the movement is slowed down by the braking action. When the bar reaches the top point, the cable is all unwound from the drum.

A drum mounted on the main pivot *C* carries a cable which runs over pulleys to the bar lying on the opposite side of the crossing, so as to operate the latter at the same time.

The current is sent into the motor by means of a second wire which is placed overhead and alongside the trolley wire. The bow or arch trolley runs over both wires at the same time, thus sending current from the trolley wire into the second wire, and as the latter is connected permanently with the motor, the current is thrown into the mechanical device all the time that the train is passing over this section. The present device is patented by the Oerlikon Electric Company.

GRADE CROSSING AT MONTREUX, SHOWING AUTOMATIC GATE. AT THE LEFT IS CABIN CONTAINING THE MECHANISM.

AUTOMATIC GATE FOR GRADE CROSSINGS.

The first essential in the storage of gasoline is a suitable tank which will keep the gasoline confined, so as to prevent vaporization. A tank should never have any flange connection or openings on the bottom or sides. All openings should be on top. The number of openings should be limited to one for the suction pipe, one for the fill pipe, and one for the vent. The installation of the tank is one of the important features, and the best method from the standpoint of safety from fire is to bury it so that the top of the tank is at least two or three feet under ground and surrounded by earth, so that there is no possibility of its being affected by the heat of any fire, no matter how great the conflagration. The tank should be vented by an inch and a quarter pipe extending up in the air so that any expelled gases will be vitiated by mixture with the air. The gas is explosive only when the proper mixture of vapor and air is made. The vent, if located near a building, should be four to six feet higher than the roof or any adjoining building, or if not near any building should extend up twelve to fifteen feet. By so venting the tank any gas which may be expelled is rendered harmless, as it is carried off and dispelled without allowing it to settle and collect. The vent should be topped by some device arranged so as to prevent water from trickling down the vent pipe. The familiar double gooseneck is inexpensive and effective. Each arm should be fitted with two fine screens which will effectively prevent any flames being drawn or forced into the tank. There should be no point in the suction line lower than the top of the tank, so that when the pipe line is damaged in case of fire no gasoline will be fed to the flames by gravity or siphonic action. For the same reason gasoline or any other volatile liquid should not be handled by any air, hydraulic, or pressure system, for in case of any hole or break in the pipe or any connection, the gasoline would be sprayed into the room or building, and endanger the lives of the firemen. Gasoline should be drawn by suction, and a pump of approved design should be located higher than the tank. All connections between the tank and pump should be made tight by some cement not affected by gasoline. With an equipment arranged as outlined, there is no chance of causing a fire.

WATERCRESS CULTURE IN FRANCE.*

A PICTURESQUE INDUSTRY.

BY JACQUES BOYER.

THE watercress (*Nasturtium officinale*) grows spontaneously on the banks of shallow running streams. In former times the markets were supplied entirely with wild watercress, which was sometimes gathered at great distance, but this cruciferous plant, which possesses stimulating and blood-purifying properties, is now cultivated on a very large scale in the suburbs of large cities. This rather picturesque variety of gardening is conducted in trenches flooded with water, by a system which originated in the environs of Dresden and Erfurt, and was introduced into France about the year 1811.

The most celebrated watercress farms in France are situated near Provins, at the sources of the rivers Voulzie and Durteint, and at St. Gratien and its neighboring villages, near Paris. In establishing a plantation, the first operation is the excavation, in well-watered meadow land, of parallel trenches 150 to 250 feet long, eight to thirteen feet wide, with an average depth of sixteen or twenty inches, and a very gentle slope (1 to 800 or 1,000). Each trench is separated from the next by a strip of grass about a yard in width. The first trench is supplied with water directly from a stream or artesian well. On reaching the end of the trench the water flows through an underground tile pipe to the second trench, from the other end of which it flows through a similar pipe into the third trench, and so on. The water thus pursues a serpentine course through the field, its flow being regulated by gates at each end of the course. Experience has proved that a trench 150 feet long and ten feet wide requires twelve or thirteen gallons of water per minute.

The plantation having once been established, some cultivators confine their attention to renewing it occasionally by cuttings. They select young, vigorous shoots bearing adventitious roots and plant them in little bunches, with the dibber, in the trenches at intervals of from two to four inches. The earth is then heaped up about the shoots, and the trenches are flooded to a depth of two inches. The water level is gradually raised as the plants increase in height, great care being taken to avoid submerging the plants entirely.

But if abundant crops are desired it is better to sow watercress seed every year. The old plants are raked off and the mud is removed with an implement which is called a rabot, or plane, and consists of a board fixed transversely on the end of a pole. The dry bottom of the trench is next strewn with well-rooted stable manure, or with superphosphate of lime, each acre receiving about three tons of manure or nine hundred pounds of superphosphate. The beds are now ready for sowing. As the seed of watercress is very fine, an ounce containing more than 120,000 seeds and a grain more than 250, the sower stands on a board thrown across the trench and holds his hand as low as possible, in order to prevent the seed being blown away or distributed irregularly by the wind. Each year, as a rule, half the beds are re-seeded.

Two weeks after sowing, when the young plants are well out of the ground, a small stream of water is admitted and the flow gradually and cautiously increased. At this time the importance of proper grading becomes evident, for if the trenches are not correctly graded the seedlings will be washed away from some places and accumulated in others. If the plants are distributed unevenly for this or other reasons it is a good plan to space them uniformly by transplanting five weeks after sowing.

Harvesting begins a month later, or within ten weeks of sowing, and continues throughout the year, except in the very cold weather, when the trenches are covered with straw to protect the plants from freezing. The harvester, wearing knee-guards to one of which a bundle of split osiers is attached by a strap, kneels on a stout plank laid across the trench and cuts the stalks, one by one, with a knife, following the direction of the current of water. As he gathers the plants he removes all dead leaves and forms the cresses into bunches, tied with osier, which he throws on the bank beside him. In spring a good harvester can gather 120 bunches in an hour, but in summer, when it is necessary to remove the flowers, he cannot accomplish quite so much, and in winter he is able to gather only about

CUTTING AND BUNCHING WATERCRESS.

WASHING AND PACKING BUNCHES OF WATERCRESS.

A SMALL WATERCRESS BED.

WATERCRESS CULTURE IN FRANCE.

* From American Homes and Gardens. Published by Munn & Co.

sixty bunches per hour. Even in winter, if the weather permits, the harvesters work from sunrise until three o'clock in the afternoon. In spring each trench can be cut once a fortnight, but an interval of twenty-five days is necessary in winter.

The bunches of watercress are carried in wheelbarrows to the washing shed, where they are again examined for defective leaves, washed in a large tank, and packed in oval baskets four feet high, each of which holds twenty dozen bunches. Each layer of bunches forms a single ring in contact with the side of the basket, leaving an open space in the center. Owing to this arrangement the cresses are not deprived of light and air during transit, and they reach their destination in good condition.

Fertilizers are applied to the beds after each cutting, and the roller is frequently drawn along the trenches for the purpose of rooting the plants in the soft mud. For the same purpose, and also in order to incorporate the fertilizer with the mud, the beds are beaten, after cutting and fertilizing, with a plank twelve inches wide and more than four feet long, attached perpendicularly to the end of a pole six feet in length. One of the photographs shows two men walking at the sides of the trench and performing this operation, which is peculiar to the culture of watercress. In winter a beater, with a perforated blade parallel to the handle, is used.

In large watercress farms it is customary to reserve the plants in one or more of the best trenches for seed, which is gathered in the latter part of June. Specialists in watercress distinguish two varieties, pale and dark green. The pale cress is the favorite. It has larger leaves than the other variety, but is less robust and more easily killed by cold.

At Provins cutting is suspended from the middle of May to the middle of August. During the nine months of harvest a trench 230 feet long, seeded annually, yields about 12,000 bunches.

Watercress can be raised on a small scale, for family use, without this elaborate system of trenches and without having a brook or an artesian well. It is merely necessary to dig a shallow pit in a well-shaded spot or on the north side of a hill, and to fill it with water. It is advisable, but not absolutely necessary, to cover the water with osier mats or wood netting. Cuttings of watercress are then strewn over the surface of the water. They soon take root and grow, and in three weeks the cress is ready for use. It is not necessary to provide a continual supply of fresh water, but the pit must be kept full of water and fertilizers should be strewn over it every three weeks. In this way an ample supply of watercress for a family can be obtained almost without expense. In cutting it is advisable to select the tallest plants, or some of those that are most crowded, thus admitting light and air to those which are left.

Another simple method of culture is recommended by Vilmorin-Andrieux. A trench ten inches deep, three feet wide, and of any length is excavated, preferably on the northern slope of a hill. The bottom of the trench is hardened by treading, and covered with a layer of rich soil mixed with leaf mold or compost, which is gently pressed into a concave form. The bed is watered copiously, allowed to dry, and sown, the seed being lightly covered with leaf mold applied with a sieve. The bed must be kept moist and a little leaf mold should be applied after each cutting. In this, as in all methods of culture, all weeds should be removed with the rake or by hand, and the plants should occasionally be entirely submerged for a few days, or sprinkled very copiously, in order to destroy insect enemies.

Watercress culture, in fact, save on a large scale, offers little difficulty and affords a crop readily grown and always available for table use. Its extensive cultivation calls for a somewhat considerable outlay, and some care must be taken to obtain the best results; but even in its most developed form it has few complications, and the crop yields are always ample.

In the towns mentioned it forms, as I have stated, a distinctive industry, a circumstance often observable in France, where the localization of industries, especially of farm or outdoor industries, are often highly developed and specialized in certain localities. The average visitor to Provins may well have an enjoyable time at this ancient town without so much as gaining any notion of the existence of the watercress industry or even so much as seeing it. Provins is, in truth, a place of the deepest interest. It is but ninety-five kilometers from Paris, and hence is within easy reach of the French capital. It consists of an old and new town, the former of which still retains the physiognomy of the Middle Ages, with most of its ancient walls and many old buildings of great historic importance.

FIRE-RESISTING BUILDING MATERIALS.

A STUDY OF THEIR QUALITIES.

A BULLETIN describing the fire-resistive qualities of building materials will be issued within a short time by the United States Geological Survey, through its Technologic Branch. Various materials used in building were subjected to the direct application of heat for two hours, in the laboratories of the National Board of Fire Underwriters, in Chicago, the temperature reaching that of a conflagration. After being exposed to the fire, the materials were withdrawn from the furnace and quenched with water, in order to get the conditions that would obtain after the firemen had begun their work on a burning building.

The investigations, which were conducted under the direction of Richard L. Humphrey, engineer in charge of the structural materials laboratory of the Survey, are the first of a comprehensive series undertaken with the object of determining the fire-resistive properties and rates of heat conductivity of various building materials and the comparative efficiency of the various methods of fireproofing. The investigations have the further object of greatly lessening the liability of loss by fire in government buildings, which are not insured, and greatly reducing their cost through more efficient methods of construction. While the tests are conducted primarily for the purpose of obtaining information of essential value to the government, it is believed that the results will prove of much importance to the public.

Mr. Humphrey in his bulletin gives the following caution: "Inasmuch as the tests herein recorded present many features of considerable importance, it has been deemed highly desirable to publish a detailed account of them, although the results are preliminary and inconclusive, and are presented solely for the purpose of making public the information acquired. They should not therefore be used as a basis for making conclusions, but merely as preliminary data regarding the relative fire-resistive qualities of the building material tested."

Regarding the tests themselves, Mr. Humphrey says: "The conditions under which these tests were made were unusually severe and none of the materials passed perfectly. The temperatures used would hardly be reached in an ordinary fire.

"Much of the damage done to the building materials in this series of tests was occasioned by internal stresses, the gas flame of the furnace heating one face of the test pieces much more rapidly than the other. All the materials tested, including the hydraulic-pressed brick, cracked more or less. The concrete cracked least, but the tests indicate the necessity for using metal reinforcement in concrete walls to distribute the effect of the expansion.

"The fact brought out most clearly by these tests is the low rate of heat transmission of Portland cement concretes and mortars. This is one of the desirable qualities in buildings intended for fireproofing purposes. For marking the cement blocks, linen tags were fastened by wire nails to the interior walls at the time of molding. Most of these tags remained in place during the test, and when the walls were demolished, the tags in every case were found entirely undamaged.

"An average of all the tests shows that about 90 per cent of the maximum temperature attained by the faces of the panels was reached in one hour, while in the case of the mortar blocks the increase in temperature of the backs of the panels in one hour was only about 20 per cent of the total increase in the two hours. Of the solid concrete panels, the cinder concrete showed the smallest increase in the temperature of the backs of the walls, and the granite concrete the largest. The total increase in the temperatures of the mortar panels was about the same as the total increase in the temperatures of the backs of the concrete, but the increase in one hour was somewhat greater in the case of concrete.

"The damage done to the faces of the mortar and concrete panels would probably be caused at a temperature about half that of the maximum temperatures reached, owing to the water of crystallization being driven from the mortar. This thin layer of dehydrated mortar may have formed a protective coating and prevented dehydration.

"The backs of the brick panels also showed a small increase in temperature, but the natural building stones and tiles proved poorer non-conductors of heat.

"It is apparent that the strength of the webs of ordinary hollow blocks is insufficient to resist the stresses set up in these tests, as in many tests the rapid rise in temperature and the subsequent quenching of one of the faces of the blocks caused the webs to split. It was noticeable that the richer the mortars used in these blocks the better they withstood the tests. The amount of water used in mixing the mortars had a similar effect on the fire-resistive qualities; the mortars mixed with the greatest percentage of water gave the best results.

"When the blocks were cracked or spalled before the application of water the damage appeared to be greater in the dry mixtures containing the greatest percentage of sand, and it was further observed during the fire test that the richer mixtures warmed up more slowly than the others. It is apparent that one of the causes of weakness in the cement hollow building blocks under these fire tests was the weakness of the concrete, a too dry and lean mixture, which, coupled with the thinness of the webs, provided insufficient strength to resist the stress due to the rapid expansion of the face. It is quite possible, as was shown in some of the block tests, to make blocks which will pass the conditions perfectly; the web must be thick enough to give the necessary strength.

"The brick panels probably withstood the tests better than the other materials. The common brick tested comprised unused new Chicago brick, and used St. Louis brick. Fifty per cent of the new bricks were split, while sixty to seventy per cent of the old bricks were not damaged. Lime knots seemed to be responsible for most of the damage to the new bricks, as they were found at the bottom of nearly all the cracks. The bricks at the back of the panels were entirely unaffected. While the strength tests are not conclusive there is apparently little difference in the strength of the bricks before and after firing.

"The hydraulic-pressed brick withstood the test very well. No damage was apparent after the firing and before the water was applied, and although a number of the bricks cracked, seventy per cent of them were found to be sound after quenching.

"The sand-lime brick did not withstand the test as well as expected, but the sample tested, which was purchased at random, appeared to be somewhat below average quality.

"The concrete behaved remarkably well and it was difficult to determine whether the limestone, granite, gravel, or cinder concrete sustained the least damage. The faces of all the panels were more or less pitted by the fire and washed away by the stream of water. The test was unfair to the cinder concrete as the cinder was very poor, containing a large percentage of unburned coal; however, the sample selected was the best of six or eight investigated in St. Louis. During the fire test the coal ignited and left the surface of the concrete very rough and badly pitted. The limestone aggregate in the face calcined, and the granite aggregate split and broke away from the surface mortar. The granite concrete probably behaved better than any of the above-mentioned concretes. Damage in no case extended deeply, probably not more than 1½ inches. The evidence shows that even at this depth the temperature was comparatively low. The high stresses produced in the panels by the rapid rise of the temperatures of the faces, while the backs remained cool; caused cracks. On taking down the panels the blocks of concrete were found to be cracked vertically for some distance from the face. The serious damage done the various natural building stones precludes any comparison among them.

"The tile tested was bought in the open market and in one panel was taken from a lot of material about to be erected in a building. A large percentage of the faces of the tiles were washed away by the water, and the material composing the faces became soft and could easily be crumbled in the fingers. There was a comparatively rapid rise in the temperature of the backs of the panels. The plaster on the partition panel tile fell off a few minutes after the test was started."

Metallic calcium dissolves in absolute alcohol, producing calcium ethoxide, $(C_2H_5O)_2$ Ca, which forms crystals containing 2 molecules of alcohol of crystallization. Calcium hydride acts upon alcohol in an analogous manner. Calcium may also be substituted for sodium in the synthesis of acetic acid esters and similar compounds. With other alcohols than ethyl alcohol the results obtained are less satisfactory.

Correspondence.

THE PASSING OF THE WHALE.

To the Editor of the SCIENTIFIC AMERICAN:

Referring to the letter of Mr. Frederic A. Lucas in SCIENTIFIC AMERICAN SUPPLEMENT for April 24th, the editor will perhaps kindly allow me some of his valuable space to give the statistics for a consecutive number of years for the two of our oldest whale fisheries, viz., that on the Finmarken coast for the years 1884-1902 and that for Iceland for the years 1889-1907:

	FINMARKEN.			ICELAND.	
Year.	Steamers.	Whales.	Year.	Steamers.	Whales.
1884	31	416	1889	4	128
1885	33	1,298	1890	7	198
1886	34	932	1891	8	206
1887	34	797	1892	9	302
1888	34	710	1893	13	495
1889	32	533	1894	15	532
1890	28	617	1895	16	768
1891	27	704	1896	18	792
1892	26	1,014	1897	23	621
1893	27	1,102	1898	21	796
1894	28	959	1899	23	868
1895	29	732	1900	23	823
1896	29	1,212	1901	27	1,192
1897	25	1,080	1902	30	1,305
1898	25	1,072	1903	22	1,037
1899	25	541	1904	24	903
1900	23	382	1905	22	941
1901	19	498	1906	25	650
1902	20	703	1907	25	843

On account of the growing adverse attitude of the fishery population in Finmarken several steamers were in course of the nineties transferred to Iceland and the Faeroes, and as these steamers generally were of the newest and more efficient type there was left behind a proportionately larger number of so-called "pails," older vessels which were not of much use either for seagoing or towing.

These statistics show, I believe, that whale-fishery is fishery, that there are good and bad years or rather periods of years just as incalculable as to their returns as for any other fishery. And what we know or more often profess to know about these, the largest animals in creation, their propagation, their ways, and their habits and numbers, are some facts, some conjectures, but more often postulates which are not always based upon a foundation of fact.

When a phenomenon appears extraordinary and there are not the data at hand whereby such phenomena can be satisfactorily explained, one is generally obliged to construct a theory and try to link together such circumstances as may be supposed reasonably to support such a theory. As nothing is known of the condition of plankton life in the Labrador current and as it cannot be reasonably expected that a community with limited resources like Newfoundland should be able to provide the means for even a modest scientific outfit for such purpose, one has to look for experiences from other whaling grounds, and a glance at the statistics given above and at those for Newfoundland show that there are some differences to be accounted for.

There is a slight error in the figures given by Mr. Lucas, as there were only eight whaling steamers in operation in Newfoundland in 1907.

Reverting, then, to the South Sea, I am a little suspicious if some enterprising newspaper man is not responsible for that "unicorn." It sounds so South Seaish! Schools of killer whales are at times swarming in that locality, feasting, and blowing so vigorously that the whalers are sometimes deceived into chasing these agile creatures.

When I mention that the catch for that one station in South Georgia was about one thousand whales in three whaling steamers during that season, I think the worthy Capt. Strumm did not see very much else but whales when he was there.

Fortunately I may say, under the present conditions, the floating factories in the neighboring bays did not or will never have the capacity of such a land station.

That South Georgia is not the market place for all the humps in the South Sea, we learn from a writer in The Zoologist, who states that one hundred and two humpbacks have also been taken by the Norwegians in Delagoa Bay. The writer expresses as his opinion that by such massacre the welfare of the colony is at stake. That there is some diversity of opinion may be inferred from his further information that he had been in the midst of a school of whales which were disporting themselves as if nothing had happened. Some people seem to foster the idea that it takes only the appearance of a school of whales in a locality for a Norwegian to invest his money with the cheerfulness of a Newfoundlander in a whaling station.

A few years ago when some people had been too busy planting and the markets were choked with vegetable oils, whale oil as a consequence went down to £14 per ton. Even with the economical administration of the Norwegian companies there were no gay gowns and ribbons for the wives and girls at that time. And if John Bull should get a fit to plant cotton with the same determination that he is planting "Dreadnoughts" at present something might happen again. One might live to see the northern whaler, forced by the southern deluge of oil, leaving the whale alone and turning to shipping. Great whaling interests have done so before in this country.

Mr. Lucas writes that we know very little of the condition of plankton anywhere. This is not very consoling to those who have for a long series of years been investigating the northern part of the Gulf Stream. For our purpose we may leave that quarter alone and turn to the South Sea.

When I mention that fourteen whaling steamers from a proportionately limited area brought the same quantity of oil as seventy in the North Atlantic, and that without even the oil from the more or less summary flensed carcasses was included, that there is also a limit to the capacity of a whaling station per day, and that this year there will be an even much greater difference in favor of the former, I think I had some valid reasons to write that the whaling grounds of the North Atlantic cannot compare with those of the southern hemisphere south of the fortieth parallel.

The whalers report immense quantities of plankton, but the fact remains that whales have at times been extremely fat and at times extremely lean, due consideration being taken of the seasons. There may, perhaps, be localities which are playing an important part in the biology of the whales from large areas, but the biological condition in such localities in corresponding seasons may be subject to great variations; we don't know.

I have seen lately the opinion expressed by a scientific man of repute that—to use his own expressions—almost everything south of the fortieth parallel needs a thorough investigation and overhauling. As such expeditions are rather costly in their running, and as those who are sitting on the woolsack will have their hands full to cater to the big guns, a more expedient way would be the combination of a sailing whaling and sealing expedition combined with thorough scientific research. Such an expedition would navigate the biologically most interesting areas, acquire much material for examination, ought, if practically conducted, pay more than its expenses, and as these quarters are now also attracting the serious attention of sealers, there might be something to look after also in the way of "the bison and the passenger pigeon."

The interests in question are of such importance, economically and otherwise, not only to the capital invested, but much more so to the whole community, present and future, that there needs something more for a just consideration than a rash conclusion from one or another defunct whaling ground or a cursory visit to some whaling station. The problems involved are too complicated for that. On the other hand, there is something considerably less complicated in the old proverb, to put the goat to take care of the oat-sack.

J. A. MÖRCH.

Christiania, Norway.

CURIOUS PROPERTIES OF NUMBERS.

To the Editor of the SCIENTIFIC AMERICAN:

The following method for finding combinations of numbers, such that the sum of the squares of the first two numbers of each combination shall equal the square of the third, may be of interest to the readers of the SCIENTIFIC AMERICAN. The question, in other words, is the solution, in positive integers, of the indeterminate equation

$$a^2 + b^2 = c^2.$$

Transposing ..... $a^2 = c^2 - b^2$ I

Factoring ..... $a^2 = (c + b)(c - b)$ ... II

Now let ..... $c + b = x$ III

and ..... $c - b = v$ IV

Adding III and IV and dividing by 2 ..... $c = \frac{x + v}{2}$ V

Subtracting IV from III and dividing by 2 ..... $b = \frac{x - v}{2}$ VI

Substituting values of III and IV in II and extracting root ..... $a = \sqrt{vx}$ VII

We now have, in equations V, VI, and VII, the quantities a, b, and c, expressed in terms of x and v. In order that the expressions $\frac{x + v}{2}$ and $\frac{x - v}{2}$ may have positive integral values, x must be greater than v, and $x + v$ and $x - v$ must have even values. Consequently x and v must be both even or both odd. Also, vx must be the square of an integral quantity, in order that a may be integral. Bearing these conclusions in mind, let $v = 1$. Then x must be odd, must be greater than 1, and must be a perfect square. That is, x may equal 9, 25, 49, 81. Substituting each of these values in turn, in equations V, VI, and VII, putting 1 for v, we obtain the following series of values for a, b, and c:

3	4	5
5	12	13
7	24	25
9	40	41, and so on.

In every combination, the sum of the squares of the first two numbers equals the square of the third.

Now, by giving greater values to v, and for each value of v, assigning increasing values to x, in accordance with the foregoing conclusions, innumerable series of combinations may be formed. As the process is continued, however, repetitions appear, either as multiples of combinations already found, or as the same combinations written in different order. For example, the combination 3 4 5 will reappear as 6 8 10, 9 12 15, etc., and again, as 4 3 5. Since it is much easier to find these repetitions of original, or "prime," combinations, by multiplication or by interchange of terms of those already found, than by following out the process described above, the writer has devised these special rules for forming series that contain only "prime" combinations:

1. If v be the square of an odd integer, x must also be the square of an odd integer.
2. If v be twice the square of an odd integer, x must be twice the square of an even integer.
3. If v be twice the square of an even integer, x must be twice the square of an odd integer.
4. x and v must be assigned no values other than those implied in the three above rules.
5. x and v must contain no common odd factor.
6. x must be greater than $v\,(3 + 2\sqrt{2})$, or, approximately, $5.828\,v$.

To illustrate the use of the rules, let $v = 18$, which is twice the square of an odd integer, 2×3^2. Then x must be twice the square of an even integer. The lowest such number, greater than $5.828\,v$, is $2 \times 8^2 = 128$. Then $a = \sqrt{vx} = \sqrt{2.3^2 . 2.8^2} = 48$; $b = \frac{x - v}{2} = \frac{128 - 18}{2} = 55$; and $c = \frac{x + v}{2} = \frac{128 + 18}{2} = 73$. $48^2 + 55^2 = 73^2$.

The next value of x is 2×10^2, and the next, 2×12^2, but this one must be excluded because it contains a factor 3 in common with v. By this method, countless series can be formed, and no time will be used in finding other than "prime" combinations.

EXPLANATION OF THE RULES.

It has been shown that x and v must be both even or both odd, and that the product vx must be a perfect square. Since $\frac{x + v}{2}$, $\frac{x - v}{2}$, and $\sqrt{vx}$, are to have no common factor, obviously x and v must have no common odd factor. For this reason, every odd factor of x and v must be an odd square. Hence rules 1 and 5. Also, when x and v are even, one must be the product of 2 and an odd square, and the other, of 2 and an even square, because, if x and v contain both an even or both an odd number of twos, the quantities $x + v$ and $x - v$ will both be divisible by 4, making the factor 2 common to a, b, and c. Thus the necessity for rules 2, 3, and 4. Rule six is intended to make $\frac{x - v}{2}$ always greater than $\sqrt{vx}$, thereby preventing the repetition of a combination in inverted order. Proof:

If $\frac{x - v}{2} > \sqrt{vx}$

$x - v > 2\sqrt{vx}$

$x^2 - 2vx + v^2 > 4vx$

$x^2 - 6vx + v^2 > 0$

$x^2 - 6vx + 9v^2 > 8v^2$

$x - 3v > \pm 2v\sqrt{2}$

$x > 3v \pm 2v\sqrt{2}$

$x > v(3 \pm 2\sqrt{2})$.

Since x is always greater than v, the form $3 + 2\sqrt{2}$ must be the result required, $3 - 2\sqrt{2}$ being less than 1.

Following are several series formed in accordance with the rules:

When $v = 2$			When $v = 8$			When $v = 9$			When $v = 32$		
8	15	17	20	21	29	33	56	65	88	105	137
12	35	37	28	45	53	39	80	89	104	153	185
16	63	65	36	77	85	51	140	149	120	209	241
20	99	101	44	117	125	57	176	185	136	273	305

Portland, Me. WILLIAM B. PIERCE.

From an investigation into the possibility of changes in the form and dimensions of the sun, F. R. Moulton gives the following conclusions: The sun is oblate and the theoretical difference in its polar and equatorial diameters is less than 0.01 sec. Its gravitational oscillations are expressible in spherical harmonics whose periods depend on their order. The change of the sun's diameter by 0.1 sec. would change its rotation period by 7.8 minutes. The expansion of the sun by 0.1 sec. would decrease its temperature (assuming its specific heat as unity) by more than 1,400 deg. C.

THE COAL-TAR DYE INDUSTRY.

ITS WONDERFUL RISE AND ITS IMPORTANCE.

THE semi-centennial celebration, in 1906, of Perkin's discovery of the first of the aniline or coal-tar dyes passed almost unnoticed by the general public, and the term "coal-tar dyes" conveys very little meaning to the majority of people. Yet these dyes are applied to a great many objects that everybody sees and uses daily—fabrics and fibers of every kind used in the manufacture of clothing, ribbons, curtains, carpets, etc., matting, straw and felt hats, leather goods, and many other articles. Of all the great chemical establishments of Germany the largest are those which are devoted to the preparation of these dyes. One of these factories has a capital of $8,000,000 and a force of more than 6,000 workers, including 200 chemists.

The art of dyeing is 3,000 years old, but the ancient dyers had only a few colors: madder, saffron, and possibly orchil for red, indigo for blue, and saffron for yellow, in addition to the celebrated Tyrian purple. The last named was the secretion of a shell fish, the others were derived from plants, and all were furnished directly by nature.

The discovery of America brought new natural dyes —cochineal, logwood, Brazilwood, quercitron, and others—and the opening of the sea route to India made indigo less costly and also stimulated the cultivation of woad, a European plant furnishing a dye very like indigo. The dyes named above, with a few of mineral origin, constituted, down to the beginning of the nineteenth century, the entire resources of the dyer, with which he colored yarns by complicated processes and often with uncertain results.

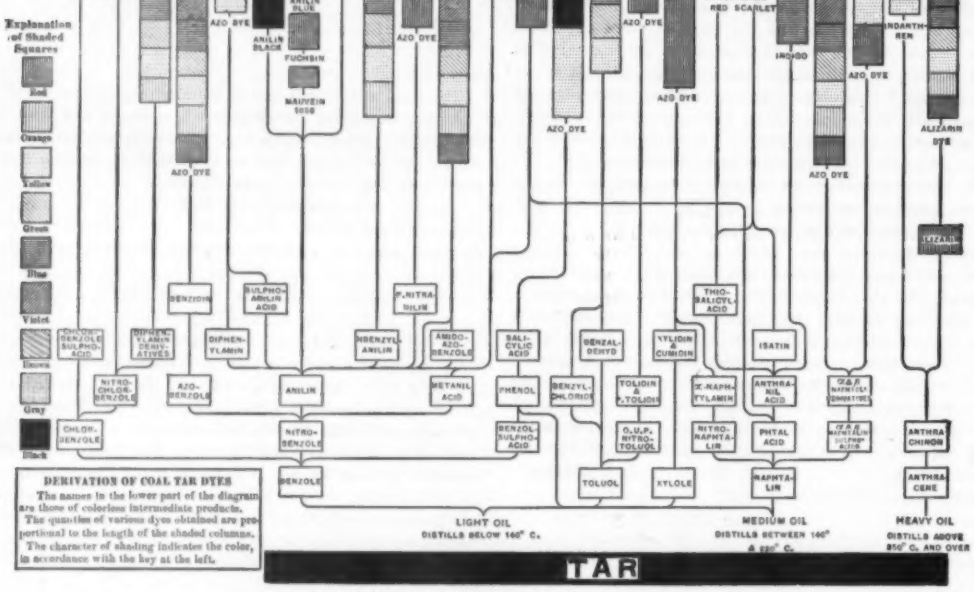
One of the first achievements of the nineteenth century, in the field of chemical technology, was the production of illuminating gas from coal. The dry distillation of bituminous coal yielded, in addition to gas, various tarry matters which were collectively named gas tar, or coal tar. This at first was a perfectly useless and annoying waste product.

In 1834 Runge obtained from coal tar, by distillation, a liquid of basic properties which he called cyanol. Before this, in 1826, Unverdorben had obtained by the dry distillation of indigo a basic liquid which he called crystallin, because it formed, with acids, crystallizable salts, and about the same time Zinin had obtained a basic liquid, which he called benzidam, by treating nitrobenzol with ammonium sulphate. Hofmann proved the identity of these three liquids. The substance is now called aniline, from *anil*, the Arabic name of indigo, and from it many of the coal-tar colors have been derived. The discoveries of Hofmann and Zinin made it possible to obtain aniline in large quantities. Coal tar contains aniline, but too little to pay for extracting. On the other hand, coal tar contains a large amount of benzol, which can easily be separated. By treatment with nitric acid, benzol can be converted into nitrobenzol, and from this aniline can be obtained by Zinin's process.

In 1856 William Henry Perkin, who was attending Hofmann's lectures at the Royal College of Chemistry in London, attempted to produce quinine by oxidizing aniline with potassium bichromate, and obtained a black precipitate. Others had done the same and gone no further, but Perkin found that the precipitate dissolved in alcohol, forming a violet solution, with which silk could be dyed. In the following year he started a factory for the production of the new dye, which was first called "Tyrian purple," and subsequently became known as mauve, aniline violet or Perkin's violet. Aniline red, or fuchsine, was discovered also in 1856, by Nathanson, but its commercial production was first accomplished in France by Berguin.

The price of aniline, at first nearly $3 per pound, was soon lowered by competition. It was treated with all sorts of reagents in the hope of producing new dyes. A mixture of aniline and fuchsine yielded aniline blue, and with the production of the first aniline yellow, called chrysaniline or phosphine, a feeble competition with vegetable dyes began.

Practice outran theory and produced dyes of which the chemical character and relations were little known. Again it was Hofmann who illuminated the darkness. He determined the chemical nature of fuchsine and discovered iodine violet and iodine green, which were at once manufactured and put on the market. They were made under pressure, often in old champagne bottles, which had a disagreeable habit of exploding, but possessed the advantage of cheapness.



DERIVATION OF COAL TAR DYES.

These two new dyes were discovered, or rather invented, in accordance with scientific principles, and they proved that the chemistry of the coal tar colors was being developed correctly. This development was further promoted by Kekulé's ingenious theory of the structure of the aromatic hydrocarbons which solved the intricate problems of isomerism.

Kekulé's pupil, Bayer, was one of the first to apply this theory to the coal-tar colors, and after seventeen years labor he achieved one of the greatest triumphs of chemistry, the synthesis of indigo.

Meanwhile Graebe and Liebermann had taken up the study of anthracene, also a constituent of coal tar. After proving that anthracene can be obtained from alizarine, the red coloring matter of the madder root, they endeavored to reverse the process, and made alizarine from anthracene. They succeeded, and so did Perkin, in the same year, 1869. The German chemists applied for an English patent one day earlier than their English rival, and so the English market was secured for German artificial alizarine. Now began the first serious competition between a natural and an artificial dyestuff. The latter won, for a root yielding one or two per cent impure coloring matter and requiring valuable land for its cultivation could not long compete with factories producing the pure dyestuff from coal tar.

In dyeing with most of the colors so far mentioned the yarn must first be impregnated with a substance, called a mordant, which has the power to fix the color. Different dyes require different mordants. Dyes which are fixed by compounds of alumina or chromium are called, simply, mordant dyes. Tannin dyes are those which require the application of tannin as a mordant. After a time the chemists succeeded in producing dyes which color wool and silk without the use of any mordant. As these dyes were obtained by treating tannin dyes with sulphuric acid, and are used in a slightly acid solution, they are called acid dyes. In this class belong the azo dyes, the manufacture of which, commenced about 1875, has developed amazingly. They are now the most important of all dyes and have been the most formidable competitors of cochineal and dyewoods.

In 1884 appeared the first direct cotton dye; that is, a dye which colors vegetable as well as animal fibers, without mordanting. Many such dyes were soon produced and were eagerly adopted by dyers, as they saved both time and money. They were not as fast as the mordant dyes, but this defect was remedied toward the end of the century by the production of the sulphur dyes, which also require no mordant on either vegetable or animal fibers and yet leave little to be desired in point of permanence.

Some of the direct cotton dyes can be changed in color, after application, by treating the dyed goods with certain reagents. Thus blue can be changed to black, and yellow to bright red, and the new colors are more permanent than the originals. This suggested the production of colors within the fibers, by the reaction of two colorless substances. Many shades are now produced in this way. They are called ice colors because the goods are usually cooled with ice during the operation. The process is cheap, as the expense of heating the vats with steam, which is necessary with most other dyes, is saved. It is also very rapid and the colors are very permanent.

Quite recently Prof. Friedlander of Vienna has produced an indigo red, which contains sulphur and is therefore called thio-indigo. In its permanence, which greatly surpasses that of indigo blue, as well as in its shade, the new dye resembles the celebrated Tyrian purple of antiquity.

Now let us glance at the magnitude and importance of the coal-tar dye industry. The first benefit it brought was the utilization of coal tar, which cheapened the production of gas and made it possible to establish gas works in small towns. The second benefit was the scientific development of the arts of dyeing and calico printing which had previously been conducted empirically and handed down from father to son. The chemists who produced the new dyes also extended their field of application and invented new methods of treating cotton, linen, silk, wool, felt, jute, furs, leather, paper, feathers, straw, tinsel, wood, and other materials. The consequence was a greatly improved market for dyed and printed goods of all sorts, and for textile fabrics in general. Improved printing machinery, capable of printing from six to twelve colors, instead of two or three, was invented. The production of the new dyes in very large quantities involved the treatment of immense amounts of raw material and necessitated the invention of machinery for crushing, disintegrating, mixing, and heating. Some of the materials are heated in iron or steel shells, called digesters or autoclaves, strong enough to withstand a pressure of 50 or 100 atmospheres. Centrifugal machines and huge filter presses are employed to separate the dyes in solid form. In the manufacture of the azo dyes large quantities of ice are used, and ice-making machinery is included in the plant. All these things benefit the steel producer, the machine builder, and the mechanical engineer, while the manufacturing chemist derives benefit from the demand for nitric, sulphuric, and hydrochloric acids, soda, dextrine, and other substances consumed in vast quantities in the manufacture and application of dyes.

In Germany the development of the coal-tar dye industry has brought another and more general benefit, for it was the principal cause of the establishment of the imperial patent office, in 1877.

Allied to the production of dyes is that of remedies, germicides, explosives, perfumes, photographic developers, and many other valuable substances from coal tar. This industry has attained gigantic proportions. A few of its most valuable and extensively used products are carbolic and salicylic acids, saccharine, antipyrine, and other febrifuges, artificial vanilla and artificial musk.

The coal-tar dye industry has conferred a benefit of incalculable value upon bacteriology and upon all mankind by furnishing dyes which, when applied to microscopic preparations, make it possible to distinguish and recognize the germs of typhoid, cholera, tuberculosis, and other diseases.

The first aniline dye was produced in England, but the manufacture of the coal-tar colors has been developed chiefly in Germany, where it may be regarded as a national industry.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Kosmos.

THE GERMAN MILITARY "ZEPPELIN I."*

DETAILED DESCRIPTION OF THE REMODELED THIRD AIRSHIP OF COUNT VON ZEPPELIN.

BY ENGINEER ANSBERT VORREITES.

THIS, the largest and most successful of the airships built by Zeppelin upon his so-called rigid system, is the remodeled third one he constructed.

The first, which made its premier ascent July 2nd, 1900, had various faults, the chief being that the stability, attained through a sliding weight hanging by ropes, was insufficient.

The second was destroyed in its first extended flight, being so badly pounded by the wind on the mountain top where Zeppelin landed to escape the fury of a sudden storm, that the framework was broken, and the inventor was obliged to take it to pieces to save the aluminium, at that time far dearer than now.

Undiscouraged by the warnings of scientists, engineers, and aeronauts, the Count succeeded in raising funds for the construction of a third airship on the same plan, which, when completed in 1907, immediately demonstrated its superiority to its predecessors.

In the period from September 26th to October 8th, 1907, this airship made various long and successful trips, showing the most admirable qualities of stability and dirigibility, and attaining a maximum speed of 14 meters (46 feet) per second, and an average speed of 10 meters (32.8 feet) per second.

After the accident in August, 1908, to the "Zeppelin IV." the "Zeppelin III" was reconstructed in the light of fresh experience.

The first step was to lengthen the frame and envelope from 128 meters (420 feet) to 136 meters (446 feet) as in the "Zeppelin IV." The diameter is 11.66 meters (38 feet) and the capacity about 12,000 cubic meters (423,768 cubic feet).

This quantity of gas is divided among 16 separate balloons, of which 12 are within the cylindrical part of the frame and 2 are found at each end. It must be observed that, strictly speaking, the form is not precisely cylindrical, since each of the rings over which the outer covering of the balloon is stretched has 16 corners, as each ring is composed of 16 straight rods.

The separate rings are fastened together by 16 longitudinal girders, which are united at each pointed end. They are further joined by 16 steel-wire cables which meet in the center, being fastened to a small ring like the spokes of a wheel.

Likewise, wire cables cross diagonally from one ring to the other in the plane of the longitudinal girders. From the inner ends of the longitudinal girders, ramie ropes are carried in the same way, so that a network is formed which holds the compartment balloons at a definite distance from the fabric stretched across the braces. Thus an air space is created between the balloons and the outer envelope. This air space is exceedingly important, and constitutes, indeed, one of the greatest advantages of Zeppelin's "rigid system."

Of especial value is the hindrance thus offered to the heating and expansion of the gas when exposed to the rays of the sun, and the consequent loss of gas.

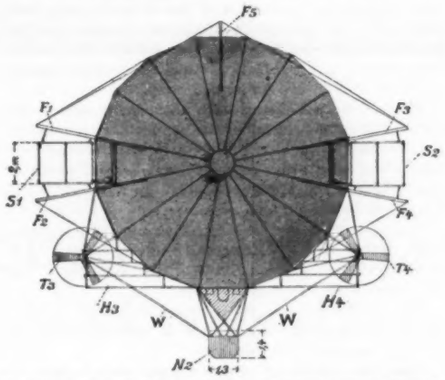
Sudden cooling of the gas when sunshine is succeeded by clouds is also avoided. In free balloons, a rise in temperature to 50 deg. C. (122 deg. F.) has been noted. This change in temperature in both free balloons and dirigibles is the chief cause of loss of gas and ballast.

The loss of gas by diffusion, too, is less in rigid than in flexible dirigibles, because the gas is not under high pressure.

In order to compensate for this loss all non-rigid balloons must be provided with one or more air-bags known as "ballonets." When the gas diminishes in volume through cooling, air is driven into the ballonet by a blower worked continuously by a motor, until the ballonet is full and the balloon envelope again fully distended.

But if the volume of gas has been lessened by more than the contents of the ballonet, the balloon cannot be thus fully inflated.

If a motor balloon loses its inflated form, it becomes more or less unsteerable and the motor must be stopped.



N_2, rear car. F_1 to F_4, lateral stabilizing planes with vertical rudders S_1 and S_2 between. F_5, upper support of stability. H_3 and H_4, rear horizontal rudder. T_3 and T_4, propellers. W, shaft for driving propellers.

FIG. 2.—REAR VIEW.

These faults are somewhat lessened by providing motor balloons with a keel framework according to the so-called semi-rigid system, but are avoided entirely only in the rigid frame as used by Zeppelin. This forms the chief advantage of the latter.

But is this improvement gained at too dear a price? The chief disadvantage is the weight of the framework, which lessens the possible weight of the cargo. This is the reason, also, that rigid-frame airships must be built on a big scale. The cubic contents of the Parseval balloon would hardly permit the Zeppelin balloon to carry its own weight, to say nothing of a cargo.

The smallest practical balloon yet built upon the Zeppelin system must have a capacity of about 6,000 cubic meters (211,884 cubic feet). From this it follows that a rigid-frame airship will need far more gas—probably twice as much—to carry a given amount of cargo, while to attain a given speed it will require more power and therefore more fuel. Furthermore, the resistance of the large balloon is correspondingly greater.

The rigid-frame airship, then, must carry more fuel to cover the same distance, but it needs less ballast because the loss of gas is less.

Another disadvantage is the far greater original cost of these airships, partly from their size, partly from the increased cost of the motors, and partly through the expense of the framework itself.

The third disadvantage is in the greater susceptibility to injury when not in the air, since the elasticity of non-rigid balloons protects them to some extent from the effects of pounding and dragging, to say nothing of the fact that injury to the envelope is far more easily and cheaply repaired than injury to the framework.

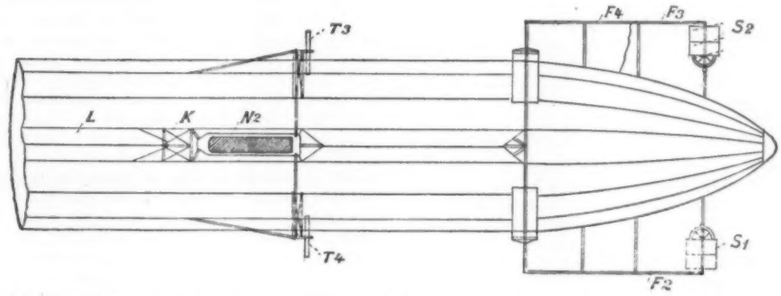
Besides, the rigid-frame balloons offer a larger surface to the pressure of the wind, and this surface cannot be lessened in time of need as is the case in the other balloons.

To sum up, the rigid-frame balloon is safer in the air, but less so on land. Also in time of storm it has difficulty in landing on large bodies of water, because of waves endangering it. On the other hand, it is commonly able to remain longer in the air than the others because of its smaller loss of gas.

Returning to the construction of the "Zeppelin I." we must observe that to give greater rigidity to the frame a keel-frame is fastened longitudinally under that of the balloon. This has a triangular cross-section, since it consists of two braces which proceed from the ends of the lower cross girders and unite underneath in a point, being each fastened by a longitudinal girder to the nearest cross girder.

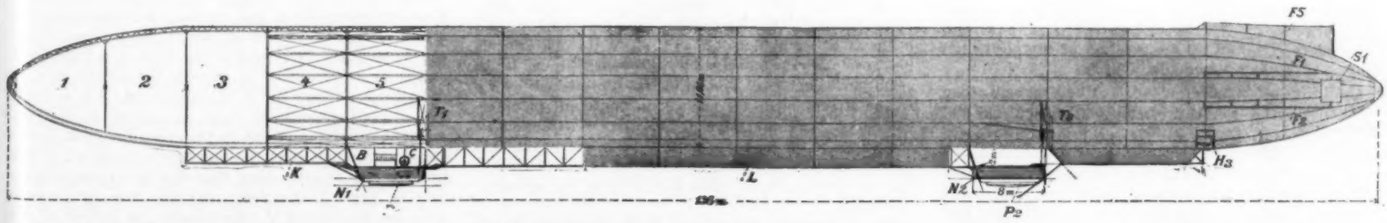
At either end of this key-frame a space is left between the fourth and sixth balloons. Into these spaces are built boat-shaped cars, made of aluminium and steel tubing. When it descends upon water the balloon floats on these cars, which are attached by an aluminium framework to the balloon frame as well as the keel-frame.

Each car is 8 meters long, 1.3 wide, and 1.4 high (26¼ x 4¼ x 4½ feet). The position of each beneath the balloon corresponds to the center of pressure for that half of the balloon. The keel is covered with canvas to lessen the resistance of the wind. The keel is floored between the cars, thus serving as a runway between them and adding to the passengers' sense of safety. Through the center rails are laid, on which a small car operated by wire ropes can be run back and forth at the will of the pilot. This serves to counterbalance any chance excess of weight in one of the cars of the airship, such, for instance, as might be caused by persons changing places. This small car serves as a tool-chest, being no longer used for a sliding weight for



K, keel frame. L, runway. N_2, rear car. F_2 to F_4, lateral stabilizing planes. S_1 and S_2, vertical rudders. T_3 and T_4, propellers.

FIG. 3.—VIEW FROM BENEATH.



1, 2, 3, 4, etc., divisions of the balloon frame. 1 to 3 in section, 4 and 5 seen from side without envelope. K, keel frame extended as runway, L. N_1, forward car. N_2, rear car. P_1, P_2, pneumatic buffers. F_1, F_2, lateral stabilizing planes with vertical rudder S_1 between them. F_5, upper stabilizing plane. H_3, one of the rear horizontal rudders; the forward ones (located between compartments 2 and 3) are not visible because of this part being shown in section. T_1 and T_2, propellers. B, board with cords for valves and ballast. C, steering wheel.

FIG. 1.—SIDE VIEW OF THE GERMAN MILITARY AIRSHIP "ZEPPELIN I," WITH PARTIAL LONGITUDINAL SECTION.

* Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

steering purposes, as was the case in the first Zeppelin model.

The upper edge of the cars is only about 6½ feet distant from the outer envelope of the balloon. This closeness is not dangerous, as might be supposed, since the air-space above described so dilutes any escaping gas as to make it neither injurious nor explosive. On the other hand, this nearness of the cars and motors to the balloon is highly advantageous, because the lateral stability obtained tends to prevent completely rolling motion. This feature was much condemned by scientists and professional men beforehand, since they believed it would cause the machine to cant, but Zeppelin stuck to his idea, with the result that the event proved his wisdom, since no other airship is so stable as his. Besides the stability given by the way in which the cars are hung, the stabilizing surfaces attached on each side at the rear also add stability, especially longitudinally, and prevent pitching.

These surfaces are double in the Zeppelin system, differing in this from all others. Though the extra weight is disadvantageous, this arrangement seems to be most favorable for the attachment of the vertical rudder. Zeppelin in his trials of "Zeppelin IV" first had vertical rudders at bow and stern, but later only at the stern. He determined that a large vertical rudder at the rear was much less effective than small multiple rudders at the sides. The bow-rudder scarcely worked at all.

These phenomena may be ascribed to the fact that in front of the balloon the air is somewhat compressed. At a considerable distance from the balloon, however, a vertical rudder would work.

These experiments with vertical rudders proved, too, that the planes fastened in front of the rudders in other airships, as those of Parseval, Gross and Lebaudy, are unnecessary. In all Zeppelin's flights the vertical rudders fastened between the stabilizing surfaces worked admirably. Each vertical rudder consists of three parallel surfaces, each of about 43 square feet area. Both can be operated, together or separately, from the forward car. At first the rudders were about in the middle of the stabilizing surfaces; later they were found to work better when attached at the rear.

For the same reason apparently in "Zeppelin IV" the stabilizing surfaces were prolonged so as to almost reach the end of the balloon. In "Zeppelin I" they terminate at about the middle of the point. Another stabilizing surface is placed vertically above the balloon, and "Zeppelin IV" also had one beneath.

The size of each of these surfaces is about 30 square meters (323 square feet) with a length of about 13 meters (42.6 feet). The upper surface cannot prevent pounding like the side surface, but it does prevent rolling and pitching. The framework of these surfaces and rudders is of aluminium covered with fabric. They are held in position by stretched wires.

The triple vertical rudders on each side of the balloon are operated by a curved rack attached to the innermost rudder and moved by a bevel gear meshing with it. Over a sprocket mounted on the same shaft with the bevel gear passes a chain which in turn is connected to a wire cable running to the steering wheel in the forward car.

The vertical steering is also much improved in this model. No other airship is so capable as "Zeppelin I" of altering its altitude by purely dynamic means; i. e., without the loss of gas or ballast.

The airship also follows the setting of the rudders very promptly—much more so than does the much smaller "Parseval II," which accomplishes vertical steering by means of ballonets attached to the ends of the balloon instead of by movable surfaces like all other modern balloons. But ballonets cannot be inflated as quickly as a lever can be pushed or a wheel turned.

Zeppelin has now accomplished in his last two models vertical steering entirely by means of movable surfaces and has dispensed with the sliding weight he formerly made use of, though he retains this method as a possibility by the situation of his tool chest.

This contingency is not apt to arise, since the horizontal rudders are double, a couple forward and a couple at the rear. Each pair can be worked separately, or both can be operated at once.

In the latter case, i. e., were the rear and forward rudders moved parallel, for example, with the forward edge toward the top, then the airship, without tilting, would be raised by the reaction of the air in the same way that an aeroplane is lifted.

If the forward rudder alone be tilted upward, then the balloon will instantly lift at the forward end and rise obliquely.

If the airship is to be made to ascend through the action of the rear rudder alone, this must be tilted with the front edge downward. The rear end of the airship will at once sink and the ship will then rise obliquely.

Each horizontal rudder consists of four parallel surfaces, attached to the first ring system of the cylindrical part of the balloon, underneath, fore and aft, at the sides.

Since the steering surfaces must lie horizontally with their axes, the form of the balloon necessitates that the upper surfaces shall be smaller than the lower.

Each pair of horizontal rudders has about 22 square meters (237 square feet) surface. Together they give a pressure of almost 600 kilogrammes at full speed, and the airship can thus be made to rise dyamically about 1,640 feet.

The Zeppelin airship can rise from the surface of water by its dynamic power alone; i. e., even when somewhat heavier than air. In fact Zeppelin has already risen with an excess weight of over 100 kilogrammes (220 lbs.)

Each car contains an 85-horse-power motor, which power enables the ship to attain a velocity of 15 meters per second, about 33.5 miles per hour. The reservoirs and casks hold together over 5,512 pounds of gasoline. Since each motor at full speed uses about 66 pounds per hour, the fuel will last 41 hours with both motors at full speed. In favorable weather the gas leakage should not be more than equal to the loss of weight from use of fuel, so that the airship should really be able to make a 40-hour trip.

All steering apparatus, such as steering wheels for the rudders, and instruments of navigation and for finding the altitude, are placed in the forward car. Here, too, the cords governing valves and sacks of water ballast are brought together on a board. The ballast sacks are divided on either side of the keel.

The cars are united by a speaking tube and provided with buffers to break the shock of landing.

As in all the Zeppelin airships, the "Zeppelin I" has four propellers, two over each car.

The screws are geared to make the same number of revolutions as do the motors in order to keep the diameter as small as possible.

One great advantage of this arrangement is that the supporting brackets for the screws do not extend so far from the balloon, so that the balloon shed is correspondingly narrower than in the case of big screws. Secondly, the weight of smaller screws and small brackets is naturally much less. The diameter of the screws is not quite 3 meters (about 9¾ feet).

The transmission of power is by inclined shafts and bevel gears. Each motor is provided with a friction clutch, so that the propellers can be stopped while the motors are kept running.

Besides water anchors, earth anchors are provided which are furnished with points like harrows. The water anchors consist of funnel-shaped frames covered with cloth.

THE YIELDING OF THE EARTH TO DISTURBING FORCES.*

THE problem of determining how much the earth as a whole actually yields to the tidal disturbing forces of the sun and moon was definitely brought before scientific men by Lord Kelvin. He pointed out that, from observations of the tides of long period, it ought to be possible to obtain some definite information, and he urged the establishment of gravitational observatories fitted with instruments for detecting the lunar disturbance of gravity. However rigid the body of the earth may be, it necessarily yields a little to the deforming action of the sun and moon. This action produces two kinds of effect. In the first place, it alters the shape of the earth. If the earth were a perfect sphere, it would be drawn out by the attraction of the moon, for instance, into a prolate ellipsoid of revolution. The actual earth, of a shape that is nearly spherical but presents certain inequalities, acquires under the action of the moon a slight additional inequality of figure, of the same type as that which answers to elongation in the direction of the long axis of the ellipsoid and flattening round the parts remote from that axis. As the moon moves relatively to the earth, the long axis of the ellipsoid moves about in the earth, so that a corporeal tide is raised in the earth. Besides raising a corporeal tide, the action of the moon alters the attraction of the earth. If the change of external shape only is taken into account, the alteration of the attraction consists of the added attraction, due to the protuberances at the ends of the long axis of the ellipsoid, coupled with the loss of attraction, due to the flattening round the parts remote from these ends. But, since the material of which the earth is made up is not homogeneous, a similar effect is produced by the elongation and flattening of the surfaces of equal density, and, since the material is not absolutely incompressible, the density must be in some parts increased and in others diminished, owing to the attraction of the moon being different in different parts. The alteration of the earth's attraction by the action of the moon is therefore of a somewhat complex character. The effects produced by the action of the sun are similar to those produced by the action of the moon.

Many attempts have been made to measure the changes of level that are due to the tidal disturbing forces of the sun and moon. In the majority of such attempts, instruments of the horizontal pendulum type have been used. The displacement of a horizontal pendulum that would be produced by the attraction of the moon, or the sun, if the earth were absolutely rigid, is known, for the attractions of the moon and sun are known. In the actual case, owing to the yielding of the earth, all we can hope to determine by observations of the tides or of the displacement of horizontal pendulums is a relative change of level, and to measure this is far from easy. The effect to be measured is extremely minute, and it is liable to be obscured, or even disguised altogether by the effects of air currents and of changes of temperature. Recently Dr. O. Hecker, of Potsdam, has succeeded in overcoming the experimental difficulties. By setting up two horizontal pendulums in an underground chamber, and observing their behavior during a protracted period, he was able to show that the effect of the moon, in particular, is perfectly definite, that in phase it follows very closely the motion of the moon, and that in amount it is almost exactly two-thirds of what it would be if the earth were absolutely rigid.

Hecker's result confirms decisively the results which had been found with much less perfect experimental means by previous observers. It leaves no shadow of doubt of the actuality of a corporeal tide produced by the moon. It accords also with those results, deduced from observations of fortnightly tides, which were used by Lord Kelvin in his famous estimate of the rigidity of the earth. This estimate was obtained by working out mathematically the change of shape that would be produced by the attraction of an external body, such as the moon, in a solid elastic globe, of the same size and mass as the earth, if the material of which it is made were homogeneous and absolutely incompressible. When these simplifying assumptions are made, the change of attraction is calculable in terms of the change of shape, and the measurement of the relative change of level leads easily to the determination of the absolute change of level. If with these simplifying assumptions there is combined the observed fact that the relative change of level is two-thirds of what it would be if the earth were absolutely rigid, it is found, as Lord Kelvin did in effect find, that the calculated rise and fall of the surface is one-third of what it would be if the earth were made of homogeneous incompressible fluid, and the calculated change of its attraction due to the sun, or moon, is one-half of the tide-generating force of the sun, or moon. The rigidity which the material, supposed homogeneous and incompressible, would need to have in order that the two numbers may have the calculated values, 1/3 and 1/2, is about the same as the rigidity of steel. Both the numbers 1/3 and 1/2, which are thus calculated, are inferred partly from a result of observation, and partly from the subsidiary hypotheses of homogeneity and incompressibility. If these hypotheses are discarded, all that can be inferred from observations of fortnightly tides and horizontal pendulums is a single equation connecting two numbers. The number which in the special case is 1/3 is in general conveniently written as $2/5h$, and the number which in the special case is 1/2 may be called k. The observations in question concur in leading to the equation $h - k = 1/3$. (In the special case $5/6 - 1/2 = 1/3$.)

It was first suggested by Prof. Simon Newcomb that the length of the earth's free period of nutation usually called the "Chandler period" may be an independent index of the yielding of the earth to small forces. It has long been known that if the earth were absolutely rigid this period would be about 306 days. A free nutation of the earth would be manifested by periodic changes of latitude of places on its surface. Small variations of latitude have long been known to exist, but all efforts of astronomers to detect a period of 306 days in these variations failed. It was announced by Dr. S. C. Chandler, in 1891, that the variations are roughly periodic, but that the period is really 427 days instead of 306. Newcomb pointed out that the lengthening of the period must be due to a yielding of the earth. At any instant the earth is rotating about an axis which does not quite coincide with a principal axis. A solid globe would be deformed by rotation into an oblate spheroid in the same way as a fluid one, but not so much. The inequality of the so-called "centrifugal force," due to the deviation of the instantaneous axis from a principal axis, produces a slight deformation of the surface, accompanied by a slight alteration of the attraction, and these effects can be specified by means of the same two numbers h and k as are required to express the effects of tidal disturbing forces. Mr. S. S. Hough, H. M.'s astronomer at the Cape of Good Hope, calculated, in 1896, the lengthening of the period in the case of a solid elastic globe of homogeneous incompressible material. The problem has recently been discussed in a more general way by Prof. G. Herglotz, who was able to dispense with the hypothesis of homogeneity. A review of the theory, as presented by Herglotz, shows that it is possible to dispense with the hypothesis of incompressibility also, and that the lengthening of the period depends upon the number k, and not upon the number h. The number k is found to be expressible in terms

* Based on a paper by Prof. A. E. H. Love, F.R.S., read before the Royal Society on January 14th.

of the two periods (306 and 427 days), the ellipticity and mean radius of the surface, the angular velocity of rotation, and the mean value of gravity at the surface. This number is therefore known. Its value is found to be about 4/15. The result that $k=4/15$ means that the alteration in the attraction of the earth on account of the distortion produced in it by the sun or moon is actually about four-fifteenths of the tide-generating force of the sun or moon. This result does not depend upon any hypothesis as to the homogeneity or incompressibility of the material. The only assumptions that are used in obtaining it are the assumption that an equilibrium theory is applicable to the forces in question, and the assumption, commonly made in the theory of the figure of the earth since the time of Laplace, viz., that the surfaces of equal density within the earth are maintained in ellipsoidal shapes by the rotation. The result does not depend upon the special hypothetical law of density which Laplace introduced. Any law of density which satisfies the ordinary laws of hydrostatics will suffice.*

* Since the paper was written and sent in to the Royal Society, Prof. Larmor has shown that the result is independent of the supposed ellipsoidal shape of the surfaces of equal density. It is therefore established, quite generally, for any constitution of the earth which would admit of the application of an equilibrium theory to forces of the type in question. It is practically certain that the actual constitution is such that a theory of this kind can be applied.

When the result expressed by the equation $k=4/15$ is combined with the result of observations of the tides and horizontal pendulums ($h-k=1/3$), it is found that $h=3/5$. This result means that the surface of the earth actually yields to the tidal deforming influence of the sun and moon by six-twenty-fifths of the amount by which it would yield if the earth were made of homogeneous incompressible fluid. The number 6/25 takes the place of Lord Kelvin's number 1/3.

The result that the earth actually yields a good deal less than Lord Kelvin supposed it to do suggests that it is decidedly more rigid than he estimated it to be. There are, however, many difficulties in the way of a more precise estimate, the chief being the heterogeneity of the material. If this fact is disregarded, and the simplifying assumption of homogeneity is made, it appears to be impossible to satisfy both the equations $h=3/5$ and $k=4/15$. An additional difficulty arises from the compressibility of the material, but, although this cannot be met directly, it is not very serious, because the general effect of compressibility must almost certainly be that any estimate of rigidity based on the simplifying assumption of incompressibility is under the mark. A possible method of procedure is to assume the earth to consist of a central nucleus of incompressible material of one density and rigidity, inclosed in a shell of incompressible material of a smaller density and a different rigidity, in the manner advocated by Prof. E. Wiechert, who regards the earth as made up of an iron core inclosed in a rocky shell. This method was developed by Dr. W. Schweydar, who found that, with the densities proposed by Wiechert, the rigidity of the core would have to be nearly three times that of steel, and the rigidity of the shell about one-eighth of that of steel. The possibility of a comparatively small rigidity in the inclosing shell suggests that there may be within it, or between it and the core, a layer of molten rock, devoid of rigidity, such as has sometimes been invoked in connection with the explanation of seismic and volcanic phenomena. This hypothesis is found, when tested mathematically, to require much too great rigidities both of the core and of the outer part of the shell. It appears, however, to be quite possible that the earth may consist of a very dense and very rigid core inclosed in, and connected by solid matter with, a lighter shell or crust, the greater part of which is solid and of a rigidity comparable with that of granite (about one-third of that of steel), the shell being honeycombed with hollow spaces containing molten matter. But it seems to be impossible that the molten matter should form a continuous layer separating the outer portions of the earth's body from the inner portions.

THE STATUS OF THE WATER-TUBE BOILER.

A REVIEW OF ITS VARIOUS FORMS.

SEVERAL years have elapsed since the question of the adaptability of water-tube boilers to naval purposes was one of the crucial questions of the day in the engineering world. The reports of the Boiler Committee were made just about the period when attention was first being diverted from the stokehold, over which bitter contention had reigned for six or seven years, to the engine-room, where the type of propelling machinery that should be adopted was the cause of sufficient controversy completely to overshadow the equally important essentials of boiler-room equipment, and since then the boiler question has been largely allowed to lapse. But although it has not attracted public attention to the same extent as has the introduction of the marine turbine, very solid progress has been made in water-tube boiler design, to the great advantage of the naval service. Quietly and without ostentation the Admiralty engineering staff has eliminated the inferior features of the multitude of types from which choice could be made ten years ago, and in the process has narrowed down to two types the boilers used in his Majesty's navy. The types with excessively bent tubes, or with bends of absurdly small radii, and those replete with screwed joints or other expensive systems of tube attachments, have all disappeared, and there remain now only the Babcock & Wilcox among the large horizontal tube types, and that of Mr. Yarrow, whose well-known simple straight tube triangular type has never varied in essentials from the time of its application to H. M. S. "Hornet." A modification of the triangular Yarrow system has more recently been introduced by the White-Forster patentees, in which all the tubes are curved to the same radius, like the staves in a barrel, and are so arranged in the boiler that, while obtaining the advantage of a predetermined direction of motion when expansion due to heat occurs, they are also so arranged that any one tube can be cut out or replaced without touching any other.

Boilers of the Thornycroft, Normand, Reed, or Blechynden type have not been countenanced in recent Admiralty boiler specifications for large vessels, which expressly stipulate that Yarrow or White-Forster boilers are to be adopted in certain cases, and Babcock boilers in others. This is the present position, and one which has obtained for a year or two, and indicates an important stage in the history of marine boilers. It is not clear why there should be two types of boiler adopted; still less is it certain that this will continue much longer. Why should the "Invincible" and "Inflexible" have Yarrow, and the "Indomitable" Babcock boilers? The coal results of the three ships for the same speed are almost identical; the Babcock boilers are slightly heavier, but have a somewhat better evaporative efficiency; the Yarrow boilers are simpler, but are possibly less easy to clean, though, on the other hand, they can stand forcing much better—no mean advantage in case of necessity. The adoption of the two types in the same class of ship certainly indicates that while the Admiralty is convinced of the merits of the two types of boiler, neither is at present so overwhelmingly superior as to be adopted exclusively.

The Yarrow type—whether Yarrow or White-Forster in detail is immaterial, as we use the name more easily to distinguish the style of design as opposed to discarded types—is that inevitably adopted in all small craft. In the larger ships its presence is as frequent as that of the Babcock type, but in these vessels there is some doubt as to whether the most economical proportions of boiler have been achieved. The navy adheres to 1¾-inch boiler tubes, and they do not facilitate good boiler design; it is still uncertain whether they are superior to 1½-inch tubes, which enable, in the opinion of many engineers, much more efficient dimensions to be achieved. In practically all the modern German ships, and in all sizes, only Schulz-Thornycroft boilers are used; the Babcock boiler is non-existent in the navy. In France, on the other hand, the large tube boiler with the relatively horizontal tubes is still generally adopted for all large warships, which are now still generally fitted with Belleville or Niclausse boilers. The United States Navy Department adheres steadfastly to the Babcock type, and has only tried the small-tube Thornycroft boiler for large ships in the "Maine" and "Missouri." It is worth remarking that the individual size of boilers in many of the United States vessels is often considerably greater than in our own service. In France, for small craft the Normand boiler is general, though White-Forster boilers are being experimentally tried in two of the new destroyers. As recently as the "Achilles" and "Duke of Edinburgh" classes, the naval vessels were burdened with several cylindrical boilers in addition to their water-tube boiler. Since then, commencing with the more recent ships of the "King Edward" class, only water-tube boilers have been adopted, and these have given general satisfaction.

We need not now adduce figures of comparative weight and space occupied in corroboration of the well-known saving in these items by water-tube over Scotch boilers. What is of more peculiar importance at the present time is that great durability and freedom from breakdown have been shown by the performance of so many of our battleships and cruisers to accompany the use of boilers of this type. This being so, why are water-tube boilers not more generally adopted, especially in Channel steamers of high speed or small draft, in which the reduction of displacement due to their use would exercise a very important influence on the design? The reason lies to a large extent in the attitude of the registration societies, to whom the Yarrow type is relatively novel. Commercial questions of durability and efficiency are admittedly very important, but they do not stop at the stokehold. If the overall weight of machinery can be so reduced by the change as to counterbalance the repair bill to a large extent—whether by decreased size of ship or by greater cargo capacity made available—then the question of repairs is of less importance. The first step is to persuade registration societies to adopt less drastic—possibly unduly severe—regulations as to frequency of thorough overhaul. If we take the boiler-room weights of a big Channel steamer of the "Ben-my-Chree" type and of, say, about 14,000 indicated horse-power, we should have about 770 tons devoted to the cylindrical boiler equipment, and about 575 if Yarrow boilers were fitted. The difference in weight is 34 per cent increase of cylindrical over water-tube boilers! Such a reduction is equivalent to a considerable saving—say 5 per cent—on the whole ship, and is worthy of some effort on the part of shipbuilders and shipowners to acquire that detailed information as to the reliability of Admiralty boilers.

The general design of the triangular type of boiler has in Admiralty hands been considerably improved in late years. More space has been allotted for the better combustion of the fuel, the size of drums and water pockets has been increased, and the requirements as to either straight or White-Forster tubes being adopted has obviated nearly all of the trouble due to the rapid wear of tubes, such as used to be experienced in the earlier types. As a further precaution, excessive combustion per square foot of heating surface has been curtailed to a limit of 1.1 pound. This is far less than obtains in both the French and German navies, where the torpedo-boat boilers are forced unmercifully. A generous allowance of grate area has also conduced to greater durability and efficiency, and in many other ways the boilers of to-day represent great improvements over those of eight or ten years ago. The attention that has of late years been devoted to types of engines, or to systems of heavy gun armament, might find profitable matter in reconsidering the boiler question.—The Engineer.

Change of route of the Loetschberg Tunnel is now assured, says Engineering News. The Swiss Department of Railways have referred the matter to the Federal council with its approval, the council has thereupon taken preliminary action on the matter. Several alternative routes were submitted, and the final decision will await a choice of most favorable route. However, the change has been authorized for that part of the relocated line on which the alternative routes coincide, so that in substance a change of location is approved. The accident which makes the change necessary was a break-in which occurred on July 24th, 1908, at the face of the north heading, which was then 8,774 feet from the north portal. The tunnel here passed under a kettle-like part of the upper valley of the Kander River, and, though nearly 600 feet below the river, it evidently had entered a depression in the rock filled by alluvial deposits—mainly fine sand. The last blast doubtless broke through the rock into this sand; at any rate, water and sand rushed in with such force that in a few minutes it filled the tunnel bore completely full for nearly a mile. Nearly the whole blasting gang was killed. Since then, the tunnel has been walled off at a point about 4,600 feet from the portal. Expert investigations have been made to determine the best plan of procedure, but their results have not been made public. Those in charge were in favor of deflecting the line of the tunnel so as to pass around the soft-ground pocket, utilizing as large a piece of the north heading as practicable, say ¾ mile, and all of the south heading so far driven (10,548 feet at the end of January, 1909). The detour would make the tunnel half a mile longer, and would introduce at least three curves. The Schweizerische Bauzeitung reports that heading work was started in the north end early in February, at 4,362 feet from the portal. The new line is to turn off from the existing north heading at 3,936 feet with a curve to the eastward.

ENGINEERING NOTES.

The London police recently lost their appearance of unemotional calm when a 26-foot Mullins steel motor boat made a speed trial run over a measured course on the Thames. The high rate of speed developed caused a great commotion among the smaller river craft, and the police wildly signaled the operator to slow down. This American-built boat made the fastest time ever made by a motor boat of its size and rated horse-power on the Thames, and is attracting great attention in the British capital.

A new process for manufacturing nitrites for fertilizing purposes has been brought out by a German inventor, Dr. Schönherr, and it is soon to be utilized on a large scale. In the Birkeland and Eyde process which is now used for obtaining nitrous products from the atmosphere, an alternating current arc is deflected by an electromagnet so as to increase its surface, and a current of air is passed upon the arc. This action produces bioxide of nitrogen. Dr. Schönherr's method is an improvement upon this. He uses an electric arc, and one of the electrodes is an insulated mass of iron. It is placed inside and at the end of an iron tube, using the tube as the other pole. When the current is passed, there is produced a somewhat short arc at first between the iron and the nearest point of the tube. Air is blown upon the end of the tube in such manner that the arc is blown into the interior of the tube and becomes of great length, following the axis of the tube. This air is transformed to bioxide of nitrogen and the present arrangement allows it to be rapidly cooled so that it escapes being decomposed. Thus we have a most simple method which requires no moving parts or electromagnet. It is easier to operate, and we have a considerable amount of power in each tube. In a 1,000-horse-power furnace the arc is said to reach several yards length and as much as 30,000 cubic feet of air can be blown through per hour. The escaping gases have 50 per cent more nitrous product than before. A syndicate has already been formed for utilizing the process in Norway. There is now building a turbine plant on the Rjukan River in that country to supply the current, and it is expected to use about 140,000 horse-power for the purpose.

That the Japanese are not always the mere imitators which some people would have us believe, is shown by the decidedly original method they have adopted for carrying two submarines from England to Japan. The "Transporter," a ship specially designed for this purpose, has been built by Messrs. Vickers, Sons & Maxim for carrying submarines intact. The engines are located aft, and forward of them the main deck for two-thirds its length has been removed. To place the submarines on board, they are floated into the drydock alongside the "Transporter." The latter is sunk to the bottom of the dock, and the submarines are then floated into position above a pair of cradles built into the hull of the ship. The water is then pumped from the dock, and, as it subsides, the submarines settle into their respective positions in the hold of the steamer. The main deck is then replaced, and the ship is pumped out until she is afloat.

SCIENCE NOTES.

Col. W. B. Leishman, writing in the Journal of the Royal Army Medical Corps, says that of 5,473 British soldiers inoculated with anti-typhoid vaccine only 21 were subsequently infected, with 2 deaths, while of the 6,610 non-inoculated in the same regiment 187 had typhoid and 26 died. Of the 21 inoculated cases 13, with 2 deaths, had received the old vaccine, which has since been greatly improved. Four cases had received only one inoculation and were mild. Only four contracted typhoid after two inoculations, and all were very mild, and, indeed, the diagnosis was doubtful in one.

The germicidal power of ultra-violet rays has long been recognized. Henri and Stodel have communicated to the French Academy of Sciences the results of their experiments in the sterilization of milk by these rays. They employed two mercury vapor quartz lamps, a Heraaus lamp of 1,500 candles and a Keuch lamp of 2,000 candles. Complete sterilization was accomplished, even when the bacterial content of the milk had been greatly increased by the addition of artificial cultures. By this method the milk is only slightly warmed. This is an important advantage, as heating milk to a high temperature makes it less digestible. Courmont and Nogier have sterilized water by placing a Kromayer lamp of 4 amperes and 135 volts in a keg of water, 24 inches in diameter. In two minutes all the bacteria were killed, while the water was only slightly heated.

Alloys of cobalt and bismuth are produced by fusing mixtures of the pulverized metals in an atmosphere of hydrogen. No heat is generated by the combination of the two metals. The alloys can be welded, and possess magnetic properties to a degree proportional to the percentage of cobalt. Bismuth can be distilled in an atmosphere of hydrogen at 2,550 deg. F. Distilled bismuth never contains any cobalt. When a very homogeneous alloy is pulverized and treated with dilute hydrochloric or nitric acid, in quantity insufficient to dissolve the whole, the residue is found to consist of pure cobalt or pure bismuth, according to the composition of the alloy. Cobalt and bismuth evidently do not combine chemically, and their miscibility in the liquid state appears to be very limited. The alloys tend to separate, cobalt accumulating at the top and bismuth at the bottom.

In a paper presented to the Académie des Sciences, M. E. Rengade discusses his researches upon the suboxides of caesium. Sub-oxides of the alkaline metals have been mentioned by different chemists, especially by Gay-Lussac and Thenard, and more recently by M. De Forerand, who obtains by the incomplete combustion of sodium in dry air, a gray substance which corresponds to the formula Na_2O. The properties of all these suboxides seem to be the same as those of a mixture of the metal and the protoxides, and the method of obtaining them does not lead us to suppose that we have to do with definite bodies. In his experiments the author seems to have formed four definite compounds, the suboxides of caesium. The first of these, Cs_4O, is fusible at +3 deg. C. The others have the composition Cs_3O, Cs_7O_2, and $Cs_{11}O_3$. He was also to isolate nearly pure crystals of the suboxide Cs_4O. These have the form of long prismatic crystals, resembling permanganate of potash in shape and color.

TRADE NOTES AND FORMULÆ.

Ink for Writing on Glass.—20 parts of brown shellac are boiled with 35 parts of borax and 250 parts of water, and after cooling mixed with 1 part of methyl violet that has been dissolved in 150 parts of alcohol.

Marking Ink for Laundry.—Add to a solution of 120 parts of logwood extract in water, 7.5 parts of yellow chromate of copper. The mixture is evaporated until thickly fluid, then add 7.5 parts of varnish. II. Fluid requiring no previous preparation: 1.4 part of soda, 1 25 part of gum arabic, 5.3 parts of distilled water. To this solution add 0.7 part of lunar caustic and 1.25 part of spirits of sal ammoniac. The mixture is heated very carefully in the water bath until it is almost black and has become clear. Applied with a steel pen, the writing first appears brown, but blackens within an hour.

The Manufacture of Pigment Paper.—75 parts of soap and 105 parts of white sugar are dissolved in 2,400 parts of water and 330 parts of gelatine are first softened by soaking and then dissolved, at moderate temperature in the water bath. 4.7 parts of dry coloring substance are rubbed down in a warm mortar, first with small, then with larger quantities of the gelatine solution and at the end filtered. The coloring matter is composed of 24 parts of India ink, 18 parts of carmine lake, 30 parts of Indian red. The paper is first laid between moist blotting paper until it is soft and lies flat. It is then placed on a leveled glass plate and the edges turned up. The colored gelatine solution is then poured over it until the layer, when it is dry, has the thickness of a visiting card. In pouring, air bubbles must be carefully avoided or they must be pierced with the corner of a piece of card.

A Good Potter's Glaze.—The following glaze meets all requirements of practical pottery, as well as those of hygiene. Although somewhat slower in fluxing than the ordinary pottery glazes, it can very well be burnt in any potter's kiln, but it must be stated in advance that the vessels must be of equally good quality, as white as possible and fireproof. 30 parts of litharge (30 parts protoxide of lead, 30 parts red lead), 5 parts white clay, 6 parts pure quartz sand. The glaze melts out well at about 2,190 deg. F. To improve it very considerably, it should remain fluid in the fire for some time, i. e., when the drawn sample shows the smooth surface, firing should be continued evenly for another two hours. During this period, the glaze combines more perfectly with the ware, by melting the silicic acid in its exterior surface, this layer being vitrified thereby. A part of the lead oxide will be volatilized and this will make the glaze richer in silicic acid, consequently harder, denser and capable of withstanding the diluted acids such as are contained in articles of food and drink.

Turpentine Soap.—As a rule, the soap is boiled from palm-kernel oil and some tallow, with 20 per cent of rosin, saponified with lye of 25 per cent, and run to clear paste. To 100 parts of the charge, use 5 to 6 per cent of black tar, such as may be obtained in stearine factories, from the distillation, and boil it with it. After it has been boiled for a time, salt it out with strong lye or salt. The lye is then removed, the grain washed out with hot water so that the soap will be transparent and run into the mold. To each 100 parts, 2 to 3 parts of oil of turpentine are added and stirred cold and finally filled with water glass, or the charge is boiled as in the Eschweg (mottled soap) process and the soap run into the mold. Then the oil of turpentine is added, the soap crutched cold and, if desired, filled with water glass. The soap thus produced has an agreeable tar odor or a turpentine smell, is usually pressed and is of dark color, approaching black.

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